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Posouzení faktorů ovlivňujících sekuritizaci aktiv komerčních bank
Assessment of the Factors Affecting the Asset Securitization Business of Commercial Banks

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Contents

1 Introduction

Asset securitization refers to the process of issuing asset-backed securities (ABS) with the support of future cash flows generated by the underlying assets. It is a form of financing to issue tradable securities supported by a specific asset portfolio or a specific cash flow. Asset securitization has gradually become a widely used financial innovation tool and has developed rapidly recently. Since the birth of securitization in the 1960s, securitization has become an important part of the modern financial system and an important tool for financial institutions in risk management and liquidity management. Before the financial crisis, asset securitization, with banks as the main body, achieved rapid growth in developed countries such as the United States, Europe and Japan. Although the outbreak of the crisis inevitably led to the shrinkage of the market and the corresponding hidden risks could not be ignored, asset securitization urged financial institutions to improve liquidity, strengthen risk management capabilities and improve profitability.

In March 2005, China began to implement securitization, but the emergence of the financial crisis caused China to suspend its pilot based on prudent consideration. As of May 2012, with the needs of commercial banks' business transformation and financial deepening, China's asset securitization pilot has restarted. The central bank, the China Securities Regulatory Commission and the China Banking Regulatory Commission have also successively changed the credit asset securitization business from an approval system to a filing or registration system. These favorable policies have driven the continuous acceleration of asset securitization. However, as the market scale continues to expand, how to deeply understand the motives for banks to develop asset securitization and explore the similarities and differences between China's bank asset securitization business and developed countries will be an important prerequisite for promoting the standardized development of China's asset securitization market.

The aim of this work is to assess whether selected macroeconomic variables and indicators of bank financial performance might influence the securitization business of the Chinese banks.

The securitization business is measured as the scale of asset securitization on the basis of the amount of asset-backed securities and mortgage back securities issued , the ten-year government bond yields and inflation rate will be used to reflect the macro factors that affect asset securitization. The profitability of bank is measured by the return on assets ratio. The risks of bank are measured by liquidity ratio and non-performing loan ratio. The ability of dealing with risk is measured by capital adequacy ratio. Return on assets, liquidity ratio ,non-performing loan ratio and capital adequacy ratio are all averaged from the 5 most influential banks in China, they are Industrial and Commercial Bank of China, Agricultural Bank of China, Bank of China, China Construction Bank and Bank of Communications. Monthly data from January 2014 to December 2019 are used in the application part of this thesis.

This work is divided into five parts, the first and last part are introduction and conclusion. Basic Concept of Asset Securitization are introduced in second part. In this part, the basic concepts of asset securitization are introduced, and the concepts of various variables are briefly explained. The third part is the information about Principles of Regression Analysis. Some principles, assumptions and verifications of regression analysis are introduced in this section. The Assessment of Asset Securitization Business Determinants in China is introduced in fourth part. In this part, the data will be applied in regression analysis to find the factors that affect China's financial futures business.

2 Basic Concept of Asset Securitization

The aim of this chapter is to introduce the basic concept of asset securitization and then describe the types and process of securitization. Finally, the focus will be on the development of asset securitization in China

2.1 Definition of Asset Securitization

In general terms, asset securitization refers to the sale of assets that lack liquidity but have predictable income by issuing securities in the capital market to obtain financing to maximize the liquidity of assets. Asset securitization is very common in some countries. Asset securitization is a direct financing method to raise funds by issuing securities in the capital and money markets.

2.1.1 Types of Securitization

Asset securitization can be divided into broad and narrow senses. (Xin Huawang, 2016) In the broadest sense, asset securitization refers to an asset or asset portfolio that adopts the form of asset operation in the form of securities assets. It includes the following four categories:

1) Physical assets securitization. That is, the conversion of physical assets to securities assets is a process of issuing securities and listing them based on physical assets and intangible assets.
2) Credit asset securitization. Credit asset securitization is the process of transforming originally illiquid financial assets into tradable capital market securities. There are many forms and types, and mortgage securities are the most common form of securitization. Refers to the reorganization of credit assets that are illiquid but have future cash flows (such as bank loans, corporate receivables, etc.) to form an asset pool and issue securities on this basis. Broadly speaking, credit asset securitization refers to the securitization of credit assets as basic assets, including the securitization of credit assets such as housing mortgage loans, car loans, consumer credit, credit card accounts, and corporate loans.

   The credit asset securitization has the advantage that it can increase the proportion of direct financing and optimize the financing structure of the financial market.

Through the securitization of credit assets, loans can be converted into securities to directly refinance the market, thereby diversifying the credit risk of the banking system and optimizing the financing structure of the financial market. At the same time, through the securitization of credit assets, the credit system and the securities market can be combined to improve the efficiency of financial resource allocation.

3) Securities asset securitization. That is, the process of re-securitization of securities assets is to use securities or portfolios as basic assets, and then issue securities based on the cash flows or variables related to cash flows.
4) Cash asset securitization. Securitization of cash assets refers to the conversion of cash assets into securities assets, that is, the process in which investors invest cash assets in securities, obtain the future cash flow of the securities, and realize the expected economic benefits.

   Cash asset securitization is achieved by investors buying securities on the market. At the same time, its reverse process-the conversion of securities assets to cash assets is achieved by investors selling securities on the securities market. The mutual conversion of cash assets and securities assets constitutes the basic activities of the securities market.

   Therefore, the securitization of cash assets can also be understood as the investment behavior of cash assets to purchase newly issued securities on the securities issuance market and purchase of issued securities in the securities circulation market.

   Cash assets themselves are fully liquid, but not profitable. Asset securitization injects securities assets into the original economy, expands the types of assets that investors can choose, diversifies investment targets, and securities assets have therefore become the investment targets of some investors. Securitization of cash assets is a way for investors to invest in securities assets.

2.1.2 Main Types of Securitized Assets

In the narrow sense, asset securitization refers to credit asset securitization. According to the types of securitized assets, credit asset securitization can be divided into Mortgage-Backed Securitization (MBS) and Asset-Backed Securitization (ABS). Securities backed by mortgage receivables are called mortgage-backed securities (MBS), while those backed by other types of receivables are asset-backed securities (ABS). We usually say that asset securitization refers to asset securitization in a narrow sense. It refers to the process of separating and reorganizing assets that lack liquidity but can generate predictable stable cash flows, and then convert them into securities that can be circulated in the financial market. This means that the assets that can generate stable cash flow are sold to an independent special purpose vehicle (SPV) specializing in asset securitization. SPV issues securities based on assets and uses the funds raised by issued securities pay the price of the purchased asset. Among them, the first party to hold and transfer assets is the institution that needs financing, and the entire process of asset securitization is initiated by it, which is called the "originator". People who buy asset-backed securities are called "investors." In the process of asset securitization, in order to reduce financing costs, in many cases, the promoter often hires a credit rating agency to rate securities credit. At the same time, in order to strengthen the credit rating of the securities issued, some credit enhancement measures will be adopted. After the issuance of securities, a special service institution is often required to collect the income of the assets and pay the income of the assets to investors in accordance with the relevant contract. Such institutions are called "servicers" (Hui Jinbo,2011).

Mortgage-backed securitization refers to financial institutions (mainly commercial banks) consolidating and reorganizing housing mortgages held by themselves with poor liquidity but having future cash income flows into mortgage loan groups. The financing process that the securitization agency purchases in cash and sells it to investors in the form of securities after guarantee or credit enhancement. This process converts previously illiquid assets that were not easily sold to investors but could produce predictable cash inflows into securities that can flow in the market.

According to different payment methods, MBS can be roughly divided into Pass-through MBS, Collateralized Mortgage Obligations and Stripped MBS. Pass-through MBS means that any cash flow generated by its asset pool is paid to investors without a tiered combination; Collateralized Mortgage Obligations (CMOs), whose cash flow is tiered and rearranged and distributed to investors with different needs ; Stripped MBS (SMBS) is divided into interest type IO (Interest Only) and principal type PO (Principal Only), which separates the principal and interest of the cash flow and pays them to the corresponding investors.

The advantages of mortgage back securitization are:

- Broaden the financing channels of commercial banks

Mortgage back securitization can transfer mortgage loans held by banks into securities and selling them to investors in the capital market to expand the bank ’s source of funds, thereby enhancing the bank ’s asset expansion capabilities.

- Reduce the operating risks of commercial banks

Securitization of mortgage loans converts low-liquidity loans into high-liquidity securities. While improving the liquidity of bank assets, it can also transfer and diversify the risk concentrated in banks to investors with different preferences.

- Improve the profitability of commercial banks

Mortgage back securitization can not only expand the bank's source of funds and enhance the liquidity of bank assets, but also create new profit growth points for the bank. On the one hand, the bank can continue to retain the service function of the securitized housing mortgage loan; including the collection of loan principal and interest, loan account records, organizing loan mortgage auctions and other related loan services, and charging service fees, which can bring to the bank Expense income. On the other hand, banks can also act as securities underwriters to provide services for the sale of mortgage-backed securities and charge a certain fee from them.

- Strengthen the capital management of commercial banks

By using asset securitization technology to securitize the mortgage loan and remove this part from the bank ’s balance sheet, the amount of risk assets of the bank can be reduced accordingly, which can increase the bank ’s capital adequacy ratio and the bank ’s credit rating.

Asset-backed securities are trust beneficiary shares issued by a trustee that represent specific purpose trusts. The trustee institution shall bear the obligation to pay the income of asset-backed securities to the investment institution within the limit of the trust property. Its payment basically comes from the cash flow generated by the asset pool supporting securities. The assets under this item are usually financial assets, such as loans or credit receivables, and according to their terms, payment is regular. The time for asset-backed securities to pay the principal often depends on the time involved in asset principal recovery. The inherent unpredictability of this principal recovery time and corresponding asset-backed securities-related principal payment time is the difference between asset-backed securities and A major feature of other bonds is the main type of fixed income securities. Assets that can be used as collateral for asset-backed securities fall into two categories: existing assets or receivables, and assets or receivables that occur in the future. The former is called "securitization of existing assets" and the latter is called "securitization of future cash flows."

Compared with other securities products, asset-backed securities have the following advantages:

- Attractive income. Among assets rated 3A, asset-backed securities have a higher yield than US Treasuries with the same maturity date, and their yields are the same as those of corporate bonds or mortgage-backed bonds with the same maturity date and credit rating the yield is roughly the same.
- High credit rating. From a credit perspective, asset-backed securities are one of the safest investment vehicles. Like other debt instruments, they are also evaluated and rated on the basis of their ability to repay principal and interest on time. However, unlike most corporate bonds, asset-backed securities are protected by collateral, and their internal structural features are enhanced by external protection measures, which further guarantees the realization of debt obligations. Most asset-backed securities received the highest credit rating from the major credit rating agencies-3A level.
- Investment diversification and diversification. The asset-backed securities market is a highly diversified market in terms of structure, income, maturity date and guarantee methods. The assets used to support securities cover different business areas, from credit card receivables to loans for cars, boats and leisure facilities, and from equipment leasing to real estate and bank loans. In addition, asset-backed securities provide investors with the conditions to enable them to diversify fixed income securities traditionally concentrated on government bonds, money market bonds, or corporate bonds.
- Predictable cash flow. The stability and predictability of the cash flow of many types of asset-backed securities have been well set. Investors who purchase asset-backed securities have great confidence to carry out the expected repayment on time. However, for asset-backed securities similar to guarantees that appear in the near future, there may be uncertainties for early repayment, so investors must understand that the predictability of cash flow is not so accurate at this time. This high degree of uncertainty is often reflected by high returns.
- The event risk is small. Since asset-backed securities are guaranteed by the underlying assets, they provide protection against the decline in ratings caused by event risks. This is more obvious than corporate bonds. Investors 'main concern for unsecured corporate bonds is that no matter how high the current rating is, the rating

agency will lower its rating once an event that has a serious impact on the issuer occurs. Similar events include mergers, acquisitions, reorganizations, and restructuring of the capital structure, which are usually implemented by the company's management in order to increase shareholders' income.

However, asset-backed securities also face many risks.

- Basic asset quality risk

The basic assets of asset-backed securities are diverse. The value of physical assets is relatively easy to determine, and the risk of asset-backed securities based on them can be predicted. But in fact, the basic assets of asset securitization are not just physical assets, such as credit card repayment securitization, which is a product that banks use future credit card repayments as basic assets to finance. In this case, the risks faced by investors are linked to the credit risk of the bank. If the credit card holder refuses to repay, the risk will be transferred to the investor. On the other hand, lenders may also conceal in order to make the underlying assets look good. The asymmetry in the reports and the actual information caused the actual quality of the basic assets to be lower than expected.

- Cash flow risk

Sometimes, even if the basic asset quality is good, there is no concealment in the disclosure, but the market is risky, and there is a small probability of the "black swan" event, which cannot be expected. Although the credit enhancement step can provide some protection, this layer of protection also has the risk of being broken down.

- Systemic risks

Systemic risk refers to the common risks faced by the entire financial market, and the entire market is affected by a large environment. Although securities are liquid, they can be sold to ensure security when there are problems in the financial environment. But this is how systemic risks spread. Once more and more people want to sell securities and fewer and fewer pick-ups, the valuable securities will become less and less valuable. Eventually no one will buy them, and the fear of default becomes a real loss.

2.1.3 Process of Securitization

In general, the main participants in a complete asset securitization financing process are sponsors, investors, ad hoc trusts, underwriters, investment banks, credit enhancement agencies or guarantee agencies, credit rating agencies, custodians, lawyers, etc. The basic operating procedures of asset securitization mainly include the 6 steps: restructure cash flow and construct securitized assets, establish an ad hoc trust institution to realize true sale and achieve bankruptcy isolation, Improve transaction structure and carry out credit enhancement, credit rating of asset securitization, arrange securities sales and pay the promoters and listed transactions and payment due.

1) Restructure cash flow and construct securitized assets

The promoter (generally a financial institution that issues loans, can also be referred to as the original equity owner) determines the asset securitization target according to its own asset securitization financing requirements, cleans up its own credit assets that can generate future cash income streams, estimation and assessment, based on historical experience data, have a basic judgment on the average level of cash flow of the entire portfolio, determine the borrower's credit, the mortgage value of the mortgage secured loan, etc., and combine receivables and foreseeable cash flow assets to cash flow The reorganization can be carried out according to the term structure of the loan, the rearrangement of principal and interest, or the redistribution of risk, etc., the number of assets is determined according to the securitization goal, and finally these assets are pooled to form an asset pool.

2) Establish an ad hoc trust institution to realize true sale and achieve bankruptcy isolation.

An ad hoc trust is an independent trust entity with the sole purpose of asset securitization. Sometimes it can also be set up by a sponsor. The activities of an ad hoc trust after registration are strictly restricted by law, and its degree of capitalization is very low. All funds are derived from the proceeds of the issuance of securities. Ad hoc trusts are the "media" for the transformation of assets into securities, and an important means of achieving bankruptcy and isolation.

3) Improve transaction structure and carry out credit enhancement

In order to improve the transaction structure of asset securitization, the ad hoc institution shall complete the signing of loan service contracts with the asset pool service company designated by the initiator, determine the custodian bank with the initiator and sign the escrow contract, and provide liquidity support when necessary with the bank A series of procedures such as turnover agreements and underwriting agreements with brokers. At the same time, after the ad hoc trust institution conducts a certain risk analysis on securitized assets, it must reorganize the risk structure of a certain set of assets and make up for the foreseeable losses through additional sources of cash flow to reduce foreseeable credit. Risk and improve the credit rating of asset-backed securities.

4) Credit rating of asset securitization

The rating of asset-backed securities provides the basis for investors to choose securities, and thus constitutes another important link of asset securitization. Ratings are performed by independent private rating agencies recognized by many investors in the international capital market. Rating considerations do not include market risk caused by changes in interest rates and other factors, but mainly consider asset credit risk.

5) Arrange securities sales and pay the promoters

After the credit enhancement and rating results are announced to investors, the underwriter is responsible for selling asset-backed securities to investors. The sales method can be underwriting or consignment. After the ad hoc trust institution obtains the securities issuance income from the underwriter, it pays most of the issuance income to the initiator at the agreed purchase price. So far, the sponsor's purpose of financing has been achieved.

6) Listed transactions and payment due

After the issuance of asset-backed securities and the application for listing on the stock exchange, the purpose of liquidity of credit assets of financial institutions has been achieved. But asset securitization has not been completed. The initiator shall designate an asset pool management company or manage the asset pool in person and is responsible for collecting and recording the cash income generated by the asset pool and depositing all these receipts into the special account of the custodian bank (Hui Jinbo 2011).

2.2 Securitization in China

China's asset securitization started relatively late. In December 2005, China Development Bank and China Construction Bank issued the first batch of asset-backed securities in the interbank market. After that, affected by the financial crisis in 2008, China stopped asset securitization. In 2011, banks began to issue asset-backed securities again. At the same time, China's political and economic environment has also led to China's asset securitization process being different from other countries.

2.2.1 Development of Securitization in China

In the past, many assets have been successfully securitized, such as accounts receivable, car loans, etc., and more types of assets have appeared, such as movie royalties, electricity bills receivables, health club memberships, etc. But the core is the same: these assets must be able to generate predictable cash flows.

China has two pilot banks for asset securitization, namely China Development Bank and China Construction Bank.

In fact, China's asset securitization pilot road is quite long. In 2005, the Central Bank and the China Banking Regulatory Commission jointly issued the "Measures for the Administration of Pilot Credit Asset Securitization Pilots". Subsequently, China Construction Bank and China Development Bank were approved to conduct the first batch of pilot credit asset securitization. Under the leadership of the central bank and the China Banking Regulatory Commission, a securitization framework based on credit assets for financing, trust-type SPVs established by trust companies, and asset-backed securities issued and circulated in the interbank bond market has basically been established.

In 2007, Pudong Development Bank, ICBC, Industrial Bank, Zhejiang Commercial Bank, and SAIC General Motors Finance Co., Ltd. and other institutions became the second batch of pilots. But when the second batch of pilot quotas was used up, the financial crisis was sweeping the globe, and the talk of securitization products changed the growth of this emerging thing abruptly.

After the credit boom in 2009, regulators' hard restrictions on capital adequacy ratios and subsequent credit tightening orders made the industry's calls for expansion or restart of asset securitization.

In May 2011, the China Banking Regulatory Commission issued the Guiding Opinions on the Implementation of New Regulatory Standards for the Chinese Banking Industry (hereinafter referred to as the Guiding Opinions). According to the requirements of the Guiding Opinions(Implementation of New Regulatory Standards for the Chinese Banking Industry ,2011)on the capital adequacy ratio and the loan ratio, the total core capital gap of 13 listed banks in China will reach 788.5 billion yuan in the next six years , and the total capital gap will reach 131.9 billion yuan. The total net profit will be doubled; the total amount of newly added provisions will reach 1,076.9 billion yuan, 1.4 times the balance of its 2010 provision.

In the "Draft for Comment", the most affected part of commercial banks will be the adjustment of the risk weight of some loans. The specific details of the medium and long-term loan risk weight adjustment have not been clarified. If the medium- and long-term loan risk weight is adjusted from 100% to 150%, according to the average of 13 listed banks, the medium- and long-term loans account for about 60% of the total loan.

To make up for this adverse effect, the total capital and core capital gaps need to be as high as approximately 900 billion yuan and 700 billion yuan, respectively. This will have a significant impact on commercial banks. Therefore, the regulatory authorities should adjust this policy with caution.

External financing channels are limited, and commercial banks are struggling to replenish capital. Since 2011, the source of supplementary capital for China's banking industry will become increasingly difficult. First, the stock market can't afford large-scale financing by commercial banks.

In 2010, China's commercial bank financing accounted for more than 40% of the total market financing scale. In that year, China's stock market won the top spot in global IPO financing, but its decline ranked third in the world. The banking industry needs long-term financing for sustainable development.

Secondly, subordinated debt got more restrictions, and regulatory authorities have imposed strict restrictions. Only a few such as Industrial Development, People's Livelihood, SPD, and SDB Banks have issued mixed capital bonds, and their issuance scales are all relatively small.

After the international financial crisis, global financial institutions' demand for capital has generally increased. European and American banks mainly raise capital through divestiture of non-core assets, while the Chinese banking industry uses large-scale financing from the capital market to supplement capital.

As early as 2005, the People's Bank of China and the China Banking Regulatory Commission jointly issued the "Measures for the Pilot Management of Credit Asset Securitization". After nearly six years of piloting, China's asset securitization has accumulated a lot of experience; and the transaction scale of China's loan transfer market has reached About 800 billion yuan, since 2009, with the large increase in the scale of new bank loans, the loan transfer business has accelerated. It is imperative to carry out asset securitization and loan transfer.

The loan structure of the Chinese banking industry has changed. Carrying out asset securitization will not only help China's commercial banks meet regulatory requirements, but also help diversify bank risks.

2.2.2 Securitization with China Commercial Banks

Bank asset securitization means that commercial banks process assets that lack liquidity but can generate predictable stable cash flows, and use these assets as guarantees to issue securities to the market, thereby converting them into securities that can be sold and circulated in the financial market. .

Bank asset securitization is an emerging financial derivative product developed in the wave of financial innovation. The rise of bank asset securitization business not only provides new financing tools for the financial market, but also brings new profit growth points for commercial banks. At the same time, it also makes financial institutions face huge challenges. It can be said that opportunities and challenges coexist.

China's financial market is still underdeveloped, and the operation of various intermediaries and investment institutions is not mature enough. As far as asset securitization is concerned, the development of credit rating agencies as necessary participants in China is still in its infancy. Therefore, it is necessary to explore and develop an asset securitization model suitable for the current development of China's financial market.

To achieve the specific goals of the promoters. There are different transaction modes, which are mainly divided into three types (Zhou Xiao,2010):

- on-balance
- off-balance
- offshore

The off-balance sheet model is the most thorough asset securitization model. The sponsor sells the assets to SPV. SPV will purchase the portfolio of assets to form an asset pool, and issue securities with the asset pool as support. The real sale of assets made the assets completely removed from the sponsor's balance sheet, separated or bankrupted, effectively achieving the goals of risk management and control. However, as far as the current situation in China is concerned, there is still a lack of SPV institutions such as the Federal Housing Loan Bank of the United States, so the off-balance sheet model is temporarily unfeasible.

The on-balance sheet model is the issue of securities directly by the sponsor, so complete bankruptcy isolation cannot be achieved, and the risk has not been transferred from the sponsor's balance sheet. The main purpose of the on-balance sheet model is to meet large financing needs, so this model is suitable for situations where the financing needs of the sponsor are greater than the risk management needs. For commercial banks, the most important goal is to achieve risk management. Therefore, this model is not applicable to asset securitization of commercial banks.

The offshore model is adopted by many enterprises in countries with low capital market development. It is based on the future cash flow of domestic assets. Through the establishment of overseas issuing agencies and intermediaries, credit enhancement and financing are implemented overseas. The advantage of the offshore model is that it makes up for the lack of domestic SPV institutions, while also expanding the demand for asset securities. But one of the shortcomings of this model is the existence of foreign exchange control and foreign exchange risks. With the deepening of China's interest rate marketization and the development of financial engineering technology, this model can become a model for commercial banks' future asset securitization exploration.

Therefore, a single operation of any of the above models is not feasible, and commercial banks should combine the on-balance sheet model with the off-balance sheet model. The specific method is that for assets with stable cash flow and high security such as mortgage loans, an on-balance sheet model can be adopted, that is, the bank acts as the initiator to issue securities. In such a case, the bank can achieve more returns. For assets that are not easy to grasp, such as non-performing assets, and assets with unstable expected returns, banks can sell them to asset management companies, that is, implement an off-balance sheet model. Asset management companies are responsible for issuing securities backed by future returns. On the one hand, this has enabled the bank to obtain the protection of bankruptcy and isolation and achieve the goal of risk management. On the other hand, it also solves the problem of banks' bad assets.

At the same time, asset securitization of Chinese commercial banks also encountered many problems.

China's capital market has become an important place for corporate financing and optimization of resource allocation. However, the development of various financing methods within the capital market is extremely uneven. China's corporate bonds have poor credit and a single variety, which is difficult to form a market hot spot. These defects have directly caused the grim situation of the bond market. The specific performance is as follows: on the one hand, due to the lack of investment and financing channels, a large amount of funds have been forced to flow into several markets with limited capacity, resulting the popular of bond and stock markets; on the other hand, due to the poor credit of corporate bonds, investors don't believe them. From this point of view, asset-backed securities can make up for the shortcomings of corporate bonds, because asset-backed securities have the characteristics of high credit ratings and strong liquidity.

The core content of asset securitization is risk transfer, credit creation, and liquidity creation. The vitality of asset-backed securities lies in their price advantages at comparable risk levels. At present, interest rates in China's financial market are administratively limited to a low level. On the one hand, most economic entities are excluded from the financial market, and they have insufficient energy and power. On the other hand, limited financial institutions such as banks have become the market. Has a relatively enough source of funds and has lost its incentive to use asset securitization technology for financing.

At the same time, on a micro level, Chinese commercial banks also have some problems. (Zhang Xindi, 2009)

1) Rating issues.

Credit rating plays a very important role in asset securitization. However, China's credit rating environment needs to be optimized urgently. The credit rating results do not reflect the correlation between risks and returns, and the risk disclosure function has not been fully reflected. False audit reports, serious debt evasion, and chaotic rating management have not yet established a relatively complete and reliable credit rating system.

2) Risk issue

- Policy risk

The government has always played a pivotal role in the formation and development of asset securitization, mainly in terms of providing institutional guarantees (such as laws, taxes, interest rates, supervision, investor protection, etc.). The initial stage of asset securitization is mostly government-led, and the risks of government policies cannot be underestimated.

- Legal risks

Asset securitization products created through property trusts are typical private equity products. Before the relevant laws were formally introduced, their identity was unclear. Moreover, without a sound legal system, the rights and obligations of each party cannot be well regulated, the ownership of benefits is clearly defined, the operational risk is reduced, and the necessary security and liquidity are provided.

- Liquidity risk

At present, an important limitation of the development of China's securitization trust products is the issue of liquidity. Insufficient liquidity of securitized products will require higher liquidity discounts, which will greatly increase the cost of securitization, which is far from the original intention of securitization to "convert illiquid assets into highly liquid securities". Therefore, improving the liquidity of securitization products is one of the core issues of China's asset securitization breakthrough model.

- Credit risk

During the entire transaction process of asset securitization, the two parties that investors rely on most are the underwriters of asset-backed securities, investment banks, and trustees who manage and control transactions on behalf of investors. Before the contract expires or before an acceptable substitute takes over, any waiver of the contract's specified duties will bring risks to investors.

3) Accounting, taxation, and legal issues.

The development of asset securitization has not only brought huge changes to the financial industry, but also brought about new accounting confirmation issues, taxation issues of securities issuance, and related issues such as debt transfer.

Therefore, China's asset securitization market needs to establish a sound credit rating mechanism as soon as possible. To improve the system of laws and regulations, on the one hand, laws and regulations on market entry, operation, and exit of SPVs should be formulated as soon as possible; on the other hand, relevant legal provisions need to be appropriately modified. At the same time, it is necessary to clarify the approval and supervision institutions. It may consider establishing a comprehensive supervision institution, which is responsible for formulating policies and regulations on asset securitization and other management systems and is responsible for guiding and supervising its implementation.

2.2.3 Factors Affecting Securitization

From the perspective of development history, asset securitization was originally born in the economic background of "financial disintermediation" in the United States, and the special mechanism inherent in this innovative process is also an important tool for banks to diversify and transfer risks. Therefore, increasing liquidity and risk transfer is regarded as the basic motivation and the main factors for banks to develop asset securitization. (Li Jia, 2018)

For "increased liquidity", the effect is the process of transferring credit portfolios to SPVs, which issues credit-backed securities to obtain liquidity. Therefore, securitization is considered as an asset financing method and can be used as a substitute for retail deposits. Or it can be regarded as the bank's third financing method except equity financing and debt financing, and the liquidity realized by this effect is not regulated by the statutory deposit reserve system. In addition, because asset securitization is conducive to supplementing liquidity, commercial banks with a profit-seeking feature hold less liquidity buffers. It can be seen that “increasing liquidity” has been regarded as the basic reason for bank asset securitization business.

At the same time, as a "credit risk transfer tool", managing credit risk is also the reason for banks' securitization. Banks will reduce credit asset risk and expected losses through securitization.

In addition to the above factors, capital adequacy ratio and profitability are also the reasons why banks carry out asset securitization. Regarding the capital adequacy ratio, the issuance of securitization by banks can reduce their own risk capital, thereby meeting the requirements of regulatory capital. At the same time, asset securitization can improve the bank's capital adequacy ratio. As for profitability, the bank's operating performance is an important influencing factor for its participation in asset securitization. Banks with poor profitability prefer to issue asset-backed securities. The larger the scale of securitization, the stronger the bank's profitability. At the same time, banks that carry out asset securitization can not only obtain market returns, but also optimize credit portfolios and create more profits.

Securitization has gradually become a hot spot in China's financial system and has affected the development strategies, operating mechanisms, and transformation of commercial banks. After several rounds of trials, the development of bank asset securitization business has become normal. Unlike developed countries, mobile Sex and transfer risk are not the main reason for bank to participate in securitization. Because of the Chinese social system, for the Bank of China, policy changes often occupy a very important position. With the issuance of new capital management regulations and the reduction of risk asset retention requirements, the incentives for regulatory capital arbitrage of banks are stronger, so the requirement of capital adequacy ratio has become an important factor affecting banks ’participation in asset securitization.

Because of China's economic development stage, financial system structure, and the characteristics of commercial banks that are significantly different from those of developed countries, traditional related research conclusions may not be suitable for China. So, it is necessary to do an analysis to find out what factors may have an impact on China's asset securitization

3 Principles of Regression Analysis

In statistics, regression analysis refers to a statistical analysis method to determine the quantitative relationship between two or more variables. Regression analysis is divided into univariate regression and multivariate regression analysis according to the number of independent variables involved.

The aim of this chapter is to introduce how to use regression analysis and how to test the model.

3.1 Ordinary Least Square Model

The population regression line is an equation that explains that the dependent variable changes due to the change of the independent variable. The basic form is:

$$y_i = \beta_0 + \beta_1 x_1 + u_i \qquad (3.1).$$

But usually all population information is not easy to obtain, it only can be known that information about a randomly selected sample of Y values for the fixed X 's, sample regression function can be estimated as:

$$y'_i = \beta'_0 + \beta'_1 x_1 + u'_i \qquad (3.2).$$

In statistics, ordinary least squares (OLS) is a type of linear least squares method for estimating the unknown parameters in a linear regression model. OLS chooses the parameters of a linear function of a set of explanatory variables by the principle of least squares: minimizing the sum of the squares of the differences between the observed dependent variable (values of the variable being observed) in the given dataset and those predicted by the linear function.

Geometrically, this is seen as the sum of the squared distances, parallel to the axis of the dependent variable, between each data point in the set and the corresponding point on the regression surface – the smaller the differences, the better the model fits the data. The resulting estimator can be expressed by a simple formula, especially in the case of a simple linear regression, in which there is a single regressor on the right side of the regression equation.

The OLS estimator is consistent when the regressors are exogenous, and optimal in the class of linear unbiased estimators when the errors are homoscedastic and serially uncorrelated. Under these conditions, the method of OLS provides minimum-variance mean-unbiased estimation when the errors have finite variances. Under the additional

assumption that the errors are normally distributed, OLS is the maximum likelihood estimator. (Wikipedia ,2020)
OLS methods is attributed to Carl Friedrich Gauss, a German mathematician. The residuals are simple the differences between the actual and estimated y values.

$$u'_i = y_i - y'_i \qquad (3.3).$$

Because the difference between the two can be positive or negative, a simple summation may cancel out a large error, and only the sum of squares can reflect the overall closeness of the two. This can be described as:

$$Q= \sum_{i=1}^{n} {u'_i}^2 \rightarrow MIN \qquad (3.4).$$

According to Lobita's law, when the first partial derivative of Q to β'_0 and β'_1 is 0, Q reaches its minimum. which can be deduced as:

$$\left.\frac{\partial Q}{\partial \beta'_0}\right| = 0 \qquad (3.5),$$

$$\left.\frac{\partial Q}{\partial \beta'_1}\right| = 0 \qquad (3.6),$$

The result is:

$$\begin{cases} \beta'_1 = \frac{n\sum_{i=1}^{n} x_i y_i - (\sum_{i=1}^{n} x_i)(\sum_{i=1}^{n} y_i)}{n\sum_{i=1}^{n} x_i^2 - (\sum_{i=1}^{n} x_i)^2} = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sum_{i=1}^{n}(x_i-\bar{x})^2} \\ \beta'_0 = \bar{y} - \beta'_1 \bar{x} \end{cases} \qquad (3.7).$$

Through formula 3.7 we obtain the method of parameter estimation by OLS model. Through this method, a univariate regression model can be established to find the relationship between independent and dependent variables.

3.2 Multivariate Regression Analysis

Multivariable regression analysis refers to treating one variable as the dependent variable and the other one or more variables as independent variables, establishing a linear or non-linear mathematical quantity relationship between multiple variables and using Statistical analysis method for analyzing sample data.
For example, economic knowledge tells us that in addition to the price P of goods, the demand for goods Q is also affected by the prices of substitutes, prices of complementary goods, and consumer income.
The mathematical model of multiple linear regression can be expressed as

$$y = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \cdots \beta_k x_{kt} + u_t, \qquad (3.8),$$

where, we assume that the dependent variable is y, and the k independent variables that affect the dependent variable are respectively$x_1, x_2 \dots x_k$. It is assumed that the effect of each independent variable on the dependent variable y is linear, that is, when the other independent variables are unchanged., The mean value of y changes uniformly with the change of the independent variable x. t is the time series , u_t is the random error. It is caused by a series of small random fluctuations of related factors in the measurement process and has a mutually compensating error. The reason for this is the influence of various unstable random factors in the analysis process, such as the instability of environmental conditions such as room temperature, relative humidity and air pressure, the small differences in the analyst's operation, and the instability of the instrument. Next, β_0 is a constant, which represents the intercept of the regression equation and β_1 to β_k are coefficients of independent variables.

Multivariate regression analysis has many assumptions:

1. The regression model is linear in the parameters.
2. The explanatory variable $x_t$is fixed in repeated sampling.
3. Zero mean value of u_t.
4. Homoscedasticity or equal variance of u_t.
5. No autocorrelation between disturbances.
6. Zero covariance between u_t and Xt.
7. The number of observations n must be greater than the number of parameters to be estimated.
8. The regression model is correctly specified.
9. There is no perfect multicollinearity among the explanatory variables.
10. u_t is normal distribution

To satisfy these assumptions, we need to perform a series of tests on the regression model.

3.3 Test of Regression Function

The aim of this chapter is to introduce how to test whether the regression model meets the assumption of multivariate regression analysis.

3.3.1 Stationary

A stationarity test of the variables is required because Granger and Newbold (1974) found that regression models for non-stationary variables give spurious results. Stationary can be classified by strictly stationary and weakly stationary.

A time series $y_t$is said to be strictly stationary if the joint distribution of (y_{t1}, ….., y_{tk})

is identical to that of (y_{t1+s}, ….., y_{tk+s}) for all integers s.

Strict stationarity requires that the joint distribution of the subsequence (y_t, ….., y_k) does not change when it is shifted by an arbitrary amount s.

If we consider that stationarity requires that all moments of the joint distribution are invariant to time shifts, we can easily understand that the distribution that generate most economic time series are not strictly stationary.

A time series $y_t$is said to be weakly or covariance stationary if the following condition hold true:

- E(y_t)=μ

The mean of the process is constant and equal to a μ. Were μ represents a fixed digit and E(y_t) is the mean of the time series data.

- Var(y_t)= $\sigma^2<\infty$

The variance od the process is time invariant and equal to finite constant σ^2. Were σ^2 represents a fixed digit and Var(y_t) is the variance of the time series data.

- Cov(y_t, y_{t+s})= γ_s

The covariance of the process should not be time dependent; it can be affected just by the distance between the two-time stick considered, equal s. Were γ_s represents a fixed digit and Cov(y_t, y_{t+s}) is the covariance between time series t data and time series t+s data.

The purpose of testing the stationary of the data rows is to determine whether the data series have a random trend or to determine the trend to prevent false regression.

To determine whether the time series exhibits some statistically significant time series dependence structure, we assume:

H0: $\rho_1 = \ldots = \rho_m = 0$

H1: $\rho_k \neq 0$ for k =1, …, m

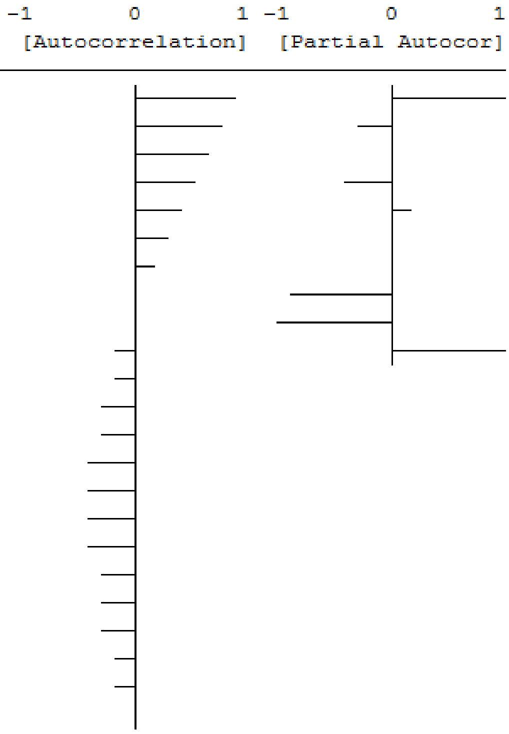
Here ρ is the correlation between the digit of data and the lags of the digit. Symbol m is how many lags it is.

We can use ACF (Auto Correlation Function) and PACF (Partial Auto Correlation Function) in STATA to show whether the data is stationary.

The example of stationarity test is shown in Figure 3.1.

Figure 3.1 Example of stationary

LAG	AC	PAC	Q	Prob>Q
1	0.8816	1.0668	21.087	0.0000
2	0.7630	-0.3516	37.597	0.0000
3	0.6509	0.0747	50.187	0.0000
4	0.5300	-0.4227	58.95	0.0000
5	0.4021	0.1944	64.259	0.0000
6	0.2741	0.0577	66.863	0.0000
7	0.1495	0.0479	67.684	0.0000
8	0.0296	-0.9439	67.718	0.0000
9	-0.0782	-1.6524	67.972	0.0000
10	-0.1596	2.0741	69.108	0.0000
11	-0.2359	.	71.778	0.0000
12	-0.3055	.	76.632	0.0000
13	-0.3501	.	83.583	0.0000
14	-0.3834	.	92.757	0.0000
15	-0.4069	.	104.24	0.0000
16	-0.4078	.	117.21	0.0000
17	-0.3934	.	131.01	0.0000
18	-0.3680	.	145.09	0.0000
19	-0.3300	.	158.68	0.0000
20	-0.2817	.	171.06	0.0000
21	-0.2265	.	181.73	0.0000
22	-0.1650	.	190.22	0.0000
23	-0.0887	.	195.13	0.0000



Source: Own calculation in Stata

Here, ACF shows the correlation between the current value and its lag quarters ago value. PACF shows that the ACF without effect of the previous lags. Q statistic test the null hypothesis that all correlation up to lag m are equal 0. This series show significant autocorrelation as shown in the Prob>Q value which at any k are less than 0.05, therefore rejecting the null hypothesis that lags are not autocorrelated. AC graph shows a slow decay in the trend, suggesting nonstationary. PAC graph measures the linear relationship existing between the process at time t and (t-k). We can clearly see the linear relationship among them. This shows that the data is not stationary.

3.3.2 Statistical Verification of the Parameters and Model

T-test

We use t-test to test hypotheses about individual regression slope coefficients. Tests of more than one coefficient at a time (joint hypotheses) are typically done with the F-test. The t-test is appropriate to use when the stochastic error term is normally distributed and when the variance of that distribution must be estimated. The t-test accounts for differences in the units of measurement of the variables.

We consider the model

$$y = \beta_1 + \beta_2 x_2 + \beta_3 x_3 + u \quad , \tag{3.9}$$

The most common test performed in regression is

$H_0: \beta_2 = 0$

$H_1: \beta_2 \neq 0$

with the t-statistic

$$t_{calculated} = \frac{\beta_2}{\sigma_{\beta_2}} \sim t_{df=n-k} \tag{3.10}$$

where k is the number of unknown parameters in the model, n is number of observations

$$t_{critical} = TINV(\alpha, df) \tag{3.11}$$

If the absolute value of $t_{calculated}$ is bigger than $t_{critical}$,we reject $H_0: \beta_2 = 0$

we say the coefficient β_2 is significant

This t-statistic (and corresponding p-value) are displayed in most regression output

If p-value(calculated) $<$ 0.05 we reject H0

F-test

We will use F-test to test whether the whole model is statistically significant. Suppose we have a model

$$y_i = \beta_1 + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \varepsilon_i \tag{3.12}$$

Suppose we want to test multiple linear hypotheses in this model. For example, we want to see if the following restrictions on coefficients hold jointly:

$$\beta_2 + \beta_3 = 1 \text{ and } \beta_4 = 0 \tag{3.13}$$

T-test cannot be used in this case because t-test can be used only for one hypothesis at a time.

We can reformulate the model by plugging the restrictions as if they were true (model under H0). We call this model restricted model as opposed to the unrestricted model. The unrestricted model is

$$y_i = \beta_1 + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \varepsilon_i \tag{3.14}$$

The restricted model is:

$$y_i = \beta_1 + \varepsilon_i \tag{3.15}$$

So, we assume

$H_0: \beta_2 = 0 \wedge \beta_3 = 0 \wedge \beta_4 = 0$

$H_A: \beta_2 \neq 0 \cup \beta_3 \neq 0 \cup \beta_4 \neq 0$

If the restrictions are true (H0), then the restricted model fits the data in the same way as the unrestricted model residuals are nearly the same .If the restrictions are false (HA), then the restricted model fits the data poorly residuals from the restricted model are much larger than those from the unrestricted model .The idea is thus to compare the sum of squared residuals from the two models and see if their difference is positive or equal to zero (statistically) .If the difference is positive, then we reject the hypothesis that the restrictions are true (we reject H0)
The test statistic is defined as

$$F_{calculated}=\frac{(RSS_R-RSS_U)/J}{RSS_U/(n-k)} \sim F_{J,n-k} \quad (3.16),$$

where RSS_R is sum of squared residuals from the restricted model. RSS_U is sum of squared residuals from the unrestricted model. Symbol J is number of restrictions. Symbol n is number of observations, k is number of estimated coefficients (including intercept)

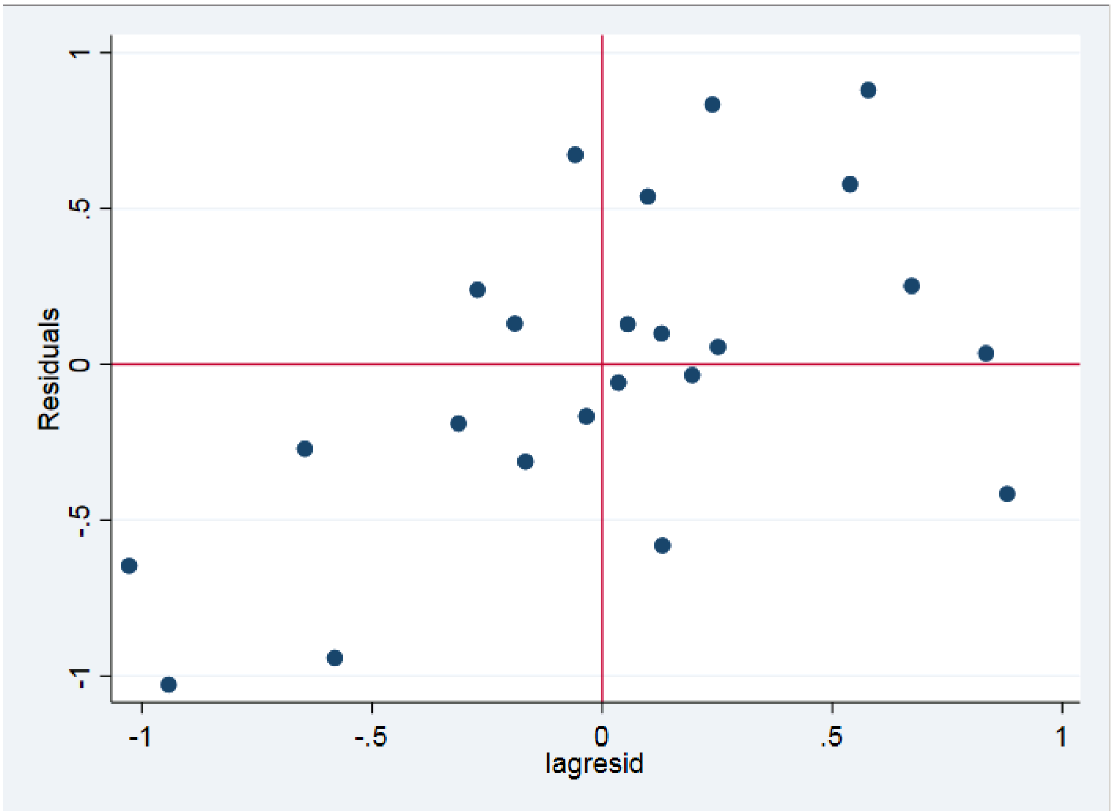
$$F_{critical}=\text{FINV}\ (\alpha,\ k\text{-}1,\ n\text{-}k) \quad (3.17).$$

If $F_{calculated}>F_{critical}$, we reject H_0, we say the overall model is significant at alfa level of significance.
If corresponding calculated p-value = sign. F<alfa = 5% then we reject H0.

3.3.3 Autocorrelation

Autocorrelation is the correlation of a signal with a delayed copy of itself as a function of delay. Informally, it is the similarity between observations as a function of the time lag between them. We can use graphs to test whether our data has autocorrelation.
For example:

Figure 3.2 Example of autocorrelation



Source: Own calculation in Stata

Figure 3.2 proves that residuals and their lagged values are positively correlated, which means autocorrelation of first order is positive. Then we can see ACF and PACF graph. ACF measures the linkage existing between time t and a lag (t-k) , regardless of observations occurring between (t-k), given,y_{t-1} …, y_{t-k+1}, which means pretending to be blinded about what happened between (t-k) and t. The PACF measures the linear relationship existing between the process at time t and (t-k).

Figure 3.3 Example of ACF graph

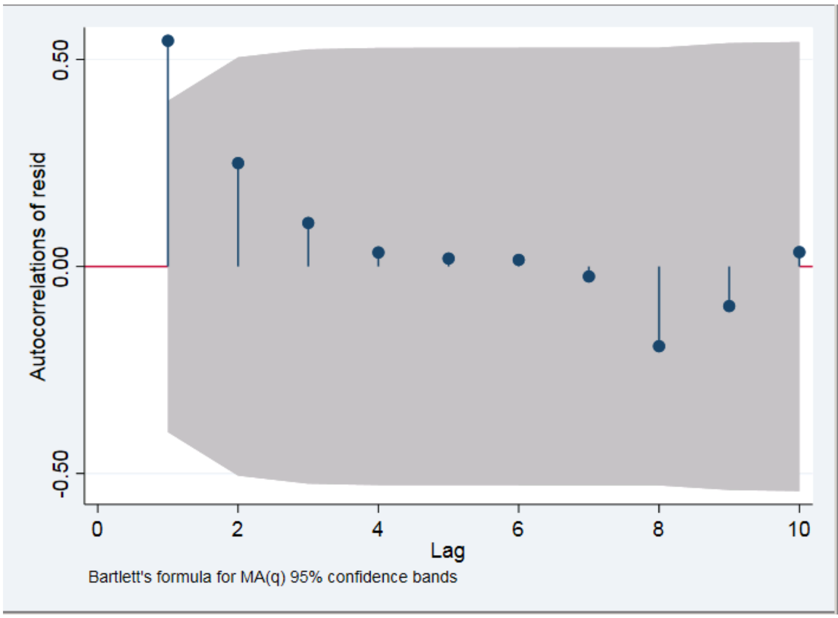
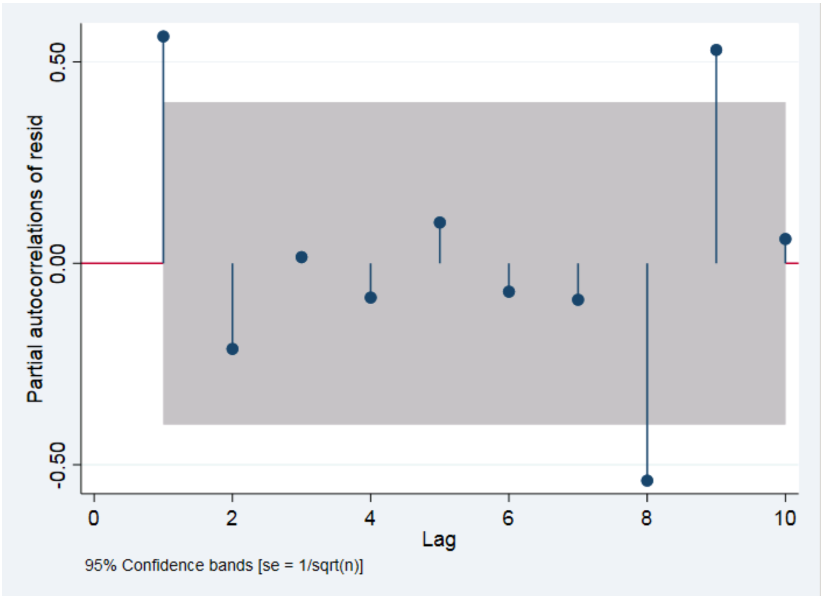


Figure 3.4 Example of PACF graph



Source: Own calculation in Stata

From Figure 3.3, we can see that only the first order is outside the gray area, which means that the autocorrelation of the first order is positive. From Figure 3.4, we can find that the autocorrelation of the first order and ninth order is positive, and the autocorrelation of the eighth order is negative.

If the time series model has autocorrelation, we assume that the error term can be expressed as Ut = ρ·Ut-1 + ε, Where Ut is error term, ρ is correlation. If ρ = 0., It means there is no autocorrelation.

The Durbin-Watson statistic (hereinafter referred to as the DW statistic) can be a tool for judging positive, negative, and zero (none) correlation. DW statistics can be described as:

$$d = \sum (Ut\text{-}Ut\text{-}1) \wedge 2 / \sum ut \wedge 2 \approx 2 \cdot (1\text{-}\rho). \qquad (3.18).$$

If d = 2, there is almost no autocorrelation. If d is close to 0, there is a positive correlation If d is close to 4, there is a negative correlation.

H0 : No autocorrelation of residuals at lag 1

H1 : Positive or negative autocorrelation of residuals at lag 1

Figure 3.5 example of DURBIN–WATSON test

```
. dwstat

Durbin-Watson d-statistic(  3,    24) =  .8733131
```

Source: Own calculation in Stata

From Figure 3.5 we can see that the result of DW test is quite a distance from 2. So, we can say that the model has an autocorrelation.

After proving the existence of autocorrelation, we need to find a way to eliminate autocorrelation. Cochrane-Orcutt method can be used to test whether the data have autocorrelation.

Figure 3.6 Example of Cochrane-Orcutt method

Cochrane-Orcutt AR(1) regression -- iterated estimates

Source	SS	df	MS
Model	.021129234	2	.010564617
Residual	.050988917	20	.002549446
Total	.072118151	22	.003278098

Number of obs	=	23
F(2, 20)	=	4.14
Prob > F	=	0.0312
R-squared	=	0.2930
Adj R-squared	=	0.2223
Root MSE	=	.05049

lnTI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnUR	-.0890887	.1625362	-0.55	0.590	-.4281333	.2499559
lnGGR	.2497008	.091171	2.74	0.013	.0595215	.4398801
_cons	16.05459	.5849448	27.45	0.000	14.83441	17.27476
rho	.9753064					

Durbin-Watson statistic (original)   0.873313
Durbin-Watson statistic (transformed) 1.540683

Source: Own calculation in Stata

From Figure 3.6 we can see that d_{cal} is 1.54, which is higher than d_u = 1.407(from Durbin Waston table), which shows that the model after using the Cochrane-Orcutt method does not have autocorrelation. But despite our elimination of autocorrelation, this model is indeed not good. The adjusted R-squared is only 0.22, and the p-value of the first coefficient is too high. So even if autocorrelation is eliminated, this new model is not good.

3.3.4 Heteroskedasticity

One of the important assumptions of the classical linear regression model is that the variance of disturbances term, conditional on the chose values of the explanatory variables, is some constant number $=\sigma^2$

$$E(u_t)= \sigma^2 t \quad t=1,2\ldots n \qquad (3.19).$$

The existence of heteroscedasticity is a major concern in the application of regression analysis, including the analysis of variance, as it can invalidate statistical tests of significance that assume that the modelling errors are uncorrelated and uniform—hence that their variances do not vary with the effects being modeled. For instance, while the ordinary least squares estimator is still unbiased in the presence of heteroscedasticity, it is inefficient because the true variance and covariance are underestimated. Similarly, in testing for differences between sub-populations using a location test, some standard tests assume that variances within groups are equal.

Because heteroscedasticity concerns expectations of the second moment of the errors, its presence is referred to as misspecification of the second order.

Heteroscedasticity is relative to homoscedasticity. The so-called homoscedasticity is to ensure that the regression parameter estimators have good statistical properties. An important assumption of the classic linear regression model is that the random error terms in the overall regression function satisfy the same variance, that is, they all have the same variance. If this assumption is not satisfied, that is, the random error terms have different variances, then the linear regression model is said to have heteroscedasticity. White 's test will be used.to test whether the model has heteroscedasticity.

Residuals are determined from the estimate of the original regression model

$$y = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + u_t \qquad (3.20).$$

Where, we assume that the dependent variable is y, independent variable is x and t is the time series, u_t is the random error. Next, β_0 is a constant, which represents the intercept of the regression equation and β_1,β_2 are coefficients of independent variables.

The new model is:

$$u_t^2 = \alpha_1 + \alpha_2 x_{1t} + \alpha_3 x_{2t} + \alpha_4 {x_{1t}}^2 + \alpha_5 {x_{2t}}^2 + \alpha_6 x_{1t} x_{2t} + \epsilon_t \qquad (3.21).$$

Where, α_1 is a constant, which represents the intercept and α_2 to α_5 are coefficients of independent variables. ϵ_t is the new error term.

This new model consists of an original model, squares of explanatory variables and cross term.

We obtain a coefficient of determination R_N^2 from estimation of a regression model

H0:$\alpha_2 = \alpha_3 = \cdots = \alpha_6 = 0$ (homoscedasticity)

H1: $\alpha_2 \neq 0\ or\ \alpha_3 \neq 0\ or \ldots \alpha_6 \neq 0$ (heteroscedasticity)

Calculated statistics X_{cal}^2=nR_{New}^2~X_{df}^2, df =k_*

Where $k_*$is the number of explanatory variables in the new model

If $X_{cal}^2 > X_{1-a}^2$(df)= CHINV(α;df), reject H0, which the variance of residuals depends on at least one explanatory variable in the new model at alfa level of significance.

3.3.5 Multicollinearity

Multicollinearity means that the explanatory variables in a linear regression model are distorted or difficult to estimate accurately due to the existence of precise or highly correlated relationships.

In general, due to the limitation of economic data, the model is not designed properly, which leads to a general correlation between explanatory variables in the design matrix. Complete collinearity is rare, and generally appears to some extent collinearity, that is, approximately collinearity.

Usually, we use VIF (Variance Inflation Factor) to detect whether the model has multicollinearity. The variance inflation factor is a measure of the severity of multicollinearity in a multiple linear regression model. It represents the ratio of the variance of the regression coefficient estimator to the variance when assuming a non-linear correlation between the independent variables.

Assuming the model has been centrally normalized, the covariance matrix of the regression coefficient estimator is $(\sigma^*)^2 r_{xx}^{-1}$, where $(\sigma^*)^2$ is the variance of the error term of the central normalized model, and r_{xx} is the correlation matrix of the independent variables, so the variance of the estimator of the regression coefficient β_k^*(1≤k≤p)of the central normalized model Equal to the product of the variance $(\sigma^*)^2$ of the error term and the k-th diagonal element in the matrix r_{xx}^{-1}. This second factor is called the coefficient of variance expansion and is denoted VIF_k. $VIF_k = (1 - R_k^2)^{-1}$, where R_k^2 is the decision coefficient between the k-th independent variable and the remaining independent variables. Therefore, the higher the correlation between the k-th independent variable and the remaining independent variables, that is, the closer R_k^2 to 1, the corresponding VIF_kwill be larger.

3.3.6 Model Specification

A model chosen for empirical analysis should satisfy some criteria.

- Parsimony. That is, the model should be as simple as possible.
- Identifiability. For a given set of data, the estimated parameter value must be unique.
- Goodness of fit is better. The higher the R-squared, the better.
- Theoretical consistency (theoretical consistency). That is, the regression results must be consistent with the theoretical analysis results.
- Predictive power. That is, the closer the predicted value is to the result verified by actual experience, the better.

Model setting errors mainly include missing relevant variables, including unnecessary variables, incorrect function forms and measurement errors. Here it is necessary to judge whether our model is a good model. If the model is not a god model, this will result in the coefficients of some variables to be ignored or the coefficients of some variables to be wrong, which will cause the entire model to be wrong.

To prevent this problem, Ramsey has proposed a general test of specification error called RESET (Regression Specification Error Test). The basic steps are

1. From the chosen model obtain the estimation $\hat{y}_i$.
2. Rerun introducing $\hat{y}_i$. in some form as an additional regressor (s):
3. Let the R^2 obtained from new model be R_{new}^2 and that from the origin model be R_{old}^2. Then we can use the F test to find out if the increase in R^2 is statistically significant.
4. If the computed F value is significant at 5% level, one can accept the hypothesis that the old model is mis-specified

3.3.7 Normality of residuals

When we do the fitting, the response variable y should be a function of the prediction variable x, but the reality is not so friendly, and there are often strange things that make x and y does not match this function. The residual in the model we made is an estimate of this random error. If the residual is not a random proof, it is still related to the predictor. Then, if the residual is normally distributed, we can consider it to be random, and if it is random, we can consider it to be a good fit to random errors.

The normal distribution of residuals should be symmetric and has a bell-shape with a pawedness and tail-thickness leading to a kurtosis of 3. Thus, we can test for departures form normality by checking the skewness and kurtosis from a sample data. If skewness is not close to zero, and if kurtosis is not close to 3, we would reject the normality of the population.

At the same time, we can use the Jarque-Bera test to check whether the residuals conform to the normal distribution. The Jarque–Bera test is a test of whether the sample data has a goodness of fit that matches the skewness and kurtosis of the normal distribution. The statistical test results are always non-negative. If the result is much greater than zero, then the data does not have a normal distribution.

H_0: residuals are normal distributed

H_1: residuals are not normal distributed

$$JB=\frac{S^2}{6/n}+\frac{(k-3)^2}{24/n} \tag{3.22}$$

where n is the number of observations (or degrees of freedom); S is the sample skewness and K is the sample kurtosis. If the sample data comes from a population with a normal distribution, the JB statistic approximately follows a chi-square distribution with a degree of freedom of 2, so this statistic can be used to test whether the data follows a normal distribution. The original assumption is that H0 has a skewness of 0 and a kurtosis of 3 (because the skewness of the normal distribution is 0 and the kurtosis is 3). The definition of the JB statistic indicates that any deviation from this (skewness of 0 and kurtosis of 3) will increase the JB statistic (Jarque ,2011).

4 Assessment of Asset Securitization Business Determinants in China

Due to special political and economic factors, the factors that affect the securitization of Chinese commercial banks' assets are somewhat different from those of other countries. The aim of this chapter is to use regression analysis to analyze the factors which may influence China 's asset securitization. The method of detection model in Chapter 3 will be applied to practice.

4.1 Data Analysis

In this part, the attention is paid to the description and analysis of used data. The securitization business is measured as the scale of asset securitization on the basis of the amount of asset-backed securities and mortgage back securities issued (Size),the unit is hundred million yuan , the ten-year government bond yields (RF) and inflation rate (IR) will be used to reflect the macro factors that affect asset securitization. The profitability of bank is measured by the return on assets ratio (ROA). The risks of bank are measured by liquidity ratio (LR) and non-performing loan ratio (NPL). The ability of dealing with risk is measured by capital adequacy ratio (CAR). The unit of RF, IR, ROA, LR, NPL and CAR is %. Return on assets, liquidity ratio ,non-performing loan ratio and capital adequacy ratio are all averaged from the 5 most influential banks in China, they are Industrial and Commercial Bank of China, Agricultural Bank of China, Bank of China, China Construction Bank and Bank of Communications. Monthly data from January 2014 to December 2019 are used in the application part of this thesis. (All data from Annex 1) The data comes from National Bureau of Statistics of China, Qianyan data web, ABS-link web.

The formula for the ratios used in this part are as follows:

$$ROA=\frac{earning\ before\ interest\ and\ tax}{total\ assets} \quad (4.1),$$

$$LR=\frac{current\ assets}{liquidity\ liability} \quad (4.2),$$

$$NPL=\frac{non-performing\ loans}{net\ loans} \quad (4.3),$$

$$CAR=\frac{capital}{risk\ weighted\ assets} \quad (4.4).$$

Table 4.1 Descriptive statistics

```
. sum Size IR ROA NPL LR CAR
```

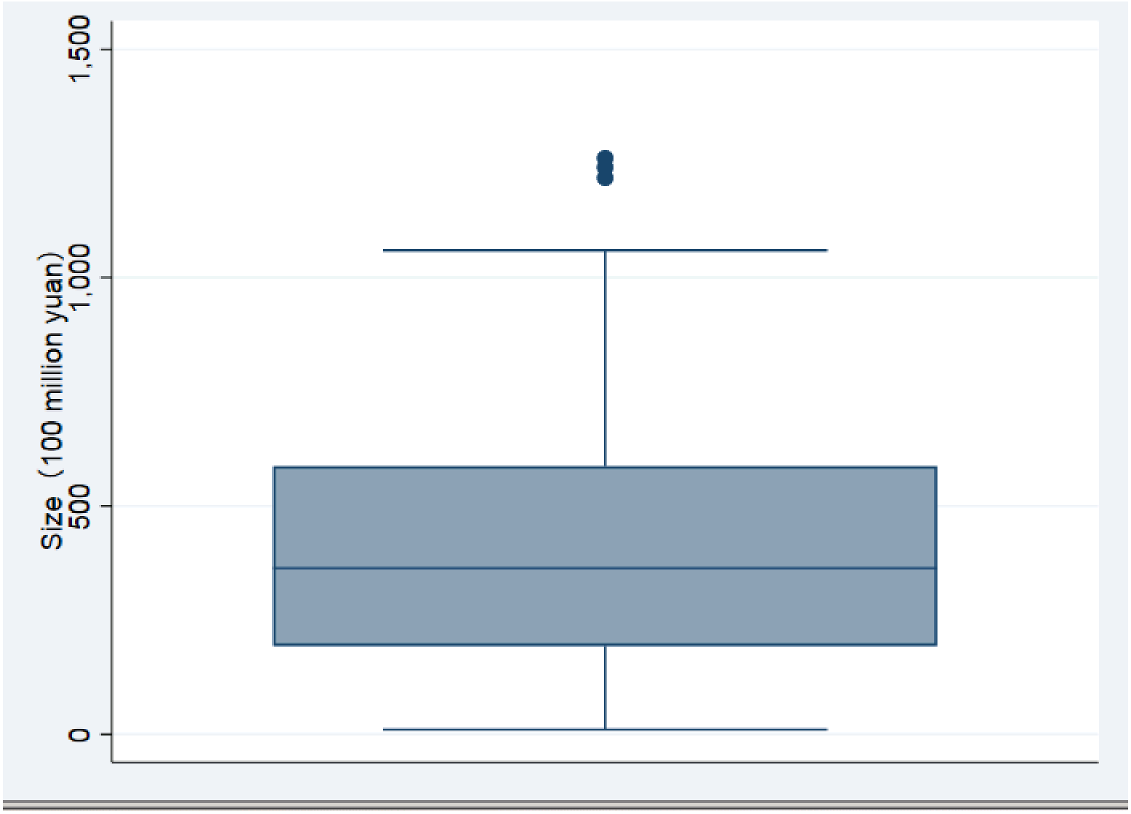
Variable	Obs	Mean	Std. Dev.	Min	Max
Size	72	427.6276	311.6558	10.41	1261.68
IR	72	1.9625	.5677823	.8	3.4
ROA	72	1.200833	.1348108	1	1.47
NPL	72	1.612639	.269198	1.01	1.87
LR	72	49.77319	3.445218	45.32	57.02
CAR	72	14.47819	.8917941	12.56	16.2

.

Source: Own calculation in Stata

From Table 4.1 we can clearly see that the standard deviation of Size is too large. The difference between the maximum and minimum values is huge. Obviously, this set of data has extreme values. So next we use box plot to determine the extreme value of this set of data.

Figure 4.1 Box plot of Size



Source: Own calculation in Stata

From Figure 4.1 we can clearly see that there are extreme values in this set of data. In order to find out the relationship between the data more conveniently, extreme values need to be eliminated. The method is to replace the extreme value by the average value of the data before and after the extreme value. At the same time, it is necessary to check whether other data have extreme values. If there are extreme values, they need to be eliminated in the same way.

As can be seen from Annex 2, there are no extreme values for other data, which means that no other data needs to be modified.

Because the assumption of linear regression is that the data is stationary, so next we test the stationary of our data. A time series is stationary if the mean has no systematic change (no trend), the variance has no systematic change, and the periodic change is strictly eliminated. The purpose of testing the stationary of the data rows is to determine whether the data series have a random trend or to determine the trend to prevent false regression. The method introduced in Chapter 3 will be applied to actual data.

Table 4.2 Stationarity of Size

(show lag 20)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.4693	0.5017	16.528	0.0000		
2	0.2560	0.0768	21.516	0.0000		
3	0.2954	0.2476	28.252	0.0000		
4	0.1266	-0.0977	29.507	0.0000		
5	0.1263	0.1158	30.776	0.0000		
6	0.2312	0.2035	35.092	0.0000		
7	0.0535	-0.0952	35.327	0.0000		
8	0.0809	0.1253	35.871	0.0000		
9	0.1976	0.2335	39.174	0.0000		
10	0.0957	0.0619	39.96	0.0000		
11	0.1715	0.2377	42.53	0.0000		
12	0.2657	0.1704	48.799	0.0000		
13	0.1352	0.0167	50.45	0.0000		
14	0.0945	0.0267	51.269	0.0000		
15	0.1120	0.0145	52.443	0.0000		
16	0.0180	0.0132	52.474	0.0000		
17	0.0127	0.0941	52.489	0.0000		
18	0.0282	0.0503	52.568	0.0000		
19	0.0119	0.2628	52.582	0.0001		
20	0.0203	0.0460	52.624	0.0001		

Source: Own calculation in Stata

As is mentioned in chapter 3, the ACF shows the correlation between the current value and its lag value and PACF shows that the ACF without effect of the previous lags. Q statistic test the null hypothesis that all correlation up to lag k are equal 0. This series show significant autocorrelation. As is shown in the Prob> Q value, which at any k are less than 0.05, therefore rejecting the null hypothesis that lags are not autocorrelated. This means that the data is not stationary. So, it should be found other form of data. The data will be transformed to ln and lag functions.

$$ln\,Factor = ln(Factor) \qquad (4.5),$$

$$d\,Factor = Factor - L.\,Factor \qquad (4.6).$$

Table 4.3 Stationarity of lnSize

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.3991	0.4141	11.955	0.0005		
2	0.1670	0.0401	14.078	0.0009		
3	0.2181	0.1912	17.751	0.0005		
4	0.1290	0.0021	19.055	0.0008		
5	0.1456	0.1207	20.742	0.0009		
6	0.2411	0.2039	25.435	0.0003		
7	-0.0061	-0.1737	25.438	0.0006		
8	-0.0040	0.0494	25.44	0.0013		
9	0.1656	0.2108	27.758	0.0010		
10	0.0596	0.0014	28.064	0.0018		
11	0.1737	0.2650	30.7	0.0012		
12	0.2867	0.1978	37.999	0.0002		
13	0.1856	0.1635	41.11	0.0001		
14	0.1141	0.0250	42.307	0.0001		
15	0.0993	-0.0347	43.228	0.0001		
16	-0.0170	-0.0687	43.255	0.0003		
17	0.0286	0.0978	43.335	0.0004		
18	0.0940	0.1544	44.207	0.0005		
19	0.0328	0.2302	44.315	0.0009		
20	-0.0577	-0.0553	44.656	0.0012		

Source: Own calculation in Stata

Table 4.4 Stationarity of lag Size

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	-0.3161	-0.3169	7.3987	0.0065		
2	-0.2368	-0.3752	11.61	0.0030		
3	0.2128	-0.0134	15.062	0.0018		
4	-0.1487	-0.2028	16.772	0.0021		
5	-0.1376	-0.2637	18.259	0.0026		
6	0.2610	0.0235	23.69	0.0006		
7	-0.1504	-0.1718	25.521	0.0006		
8	-0.1433	-0.2548	27.21	0.0007		
9	0.2270	-0.0776	31.518	0.0002		
10	-0.0986	-0.2364	32.345	0.0004		
11	0.0013	-0.1484	32.345	0.0007		
12	0.1780	-0.0053	35.127	0.0004		
13	-0.0882	-0.0171	35.823	0.0006		
14	-0.0753	-0.0112	36.339	0.0009		
15	0.0913	-0.0069	37.111	0.0012		
16	-0.1116	-0.0721	38.285	0.0014		
17	0.0101	-0.0097	38.295	0.0022		
18	0.0261	-0.2132	38.362	0.0035		
19	-0.0022	0.0028	38.363	0.0053		
20	0.0439	0.1346	38.559	0.0076		

Source: Own calculation in Stata

Unfortunately, even if the form of the data is modified, this set of data is still non-stationary.

4.2 Univariable Regression Analysis

In this part we will use the OLS method perform regression analysis on the dependent variable and each independent variable. Through a univariate regression model, we will find which variable influences Size. Although in the subsequent multivariate regression model, due to the interaction between the independent variables, it may not be possible to show the role of some variables, but through the univariate regression model, we have at least proved that these independent variables have an effect on the dependent variable ..
In all the following univariable models, we use the scale of asset securitization as dependent variable and the selected factors and independent variables.
First, the amount of asset-backed securities and mortgage back securities issued will be used to reflect the scale of asset securitization (Size). The ten-year government bond rate (RF) and inflation rate (IR) will be used to reflect the macro factors that affect asset securitization. Finally, the return on assets (ROA) will be used to reflect the profitability of the bank and the liquidity ratio (LR) and non-performing loan ratio (NPL) will be used to reflect the risks of bank. The capital adequacy ratio (CAR) will reflect the ability of dealing with risk. ROA, liquidity ratio, non-performing loan ratio and CAR are all averaged from the 5 most influential banks in China

- Industrial and Commercial Bank of China
- Agricultural Bank of China
- Bank of China
- China Construction Bank
- Bank of Communications

Monthly data from January 2014 to December 2019 are used in this thesis.

Table 4.5 Regression model of Size and RF

```
regress Size Rf

      Source |       SS           df       MS      Number of obs   =        72
-------------+----------------------------------   F(1, 70)        =      3.15
       Model |  304664.415         1  304664.415   Prob > F        =    0.0803
    Residual |  6769694.58        70  96709.9226   R-squared       =    0.0431
-------------+----------------------------------   Adj R-squared   =    0.0294
       Total |  7074358.99        71  99638.8591   Root MSE        =    310.98

------------------------------------------------------------------------------
        Size |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          Rf |  -148.9466   83.91802    -1.77   0.080    -316.3158    18.42262
       _cons |   939.0347   293.5148     3.20   0.002     353.6379    1524.431
------------------------------------------------------------------------------
```

Source: Own calculation in Stata

We can see that p-value greater than 0.05 means greater than significant level. And the R-squared is very low. This means that only a few changes in Size can be explained by RF. So, we can basically predict that RF has no statistically significant effect on the size change. So, the following analysis will not include RF.

Table 4.6 Regression model of Size and IR

```
. regress Size IR

      Source |       SS           df       MS      Number of obs   =        72
-------------+----------------------------------   F(1, 70)        =     27.71
       Model |  1955925.94         1  1955925.94   Prob > F        =    0.0000
    Residual |  4940255.13        70  70575.0732   R-squared       =    0.2836
-------------+----------------------------------   Adj R-squared   =    0.2734
       Total |  6896181.07        71  97129.3108   Root MSE        =    265.66

------------------------------------------------------------------------------
        Size |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          IR |   292.3245   55.52833     5.26   0.000     181.5767    403.0722
       _cons |  -146.0591   113.3826    -1.29   0.202    -372.1936    80.07538
------------------------------------------------------------------------------
```

Source: Own calculation in Stata

We can see that p-value is less than 0.05 which means less than significant level. And the coefficient is positive, which shows that the amount of asset-backed securities and the inflation rate have a positive change relationship. This is in line with our expectations. Because as the inflation rate rises, purchasing power of cash is depreciating. Low-liquidity assets in the hands of banks will become less and less valuable. At this time, banks will issue many asset-backed securities to transfer this risk.

Table 4.7 Regression model of Size and ROA

```
. regress Size ROA

      Source |       SS           df       MS      Number of obs   =        72
-------------+----------------------------------   F(1, 70)        =     18.87
       Model |  1464026.75         1  1464026.75   Prob > F        =    0.0000
    Residual |  5432154.32        70  77602.2045   R-squared       =    0.2123
-------------+----------------------------------   Adj R-squared   =    0.2010
       Total |  6896181.07        71  97129.3108   Root MSE        =    278.57

------------------------------------------------------------------------------
        Size |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         ROA |  -1065.174   245.2355    -4.34   0.000    -1554.281   -576.0678
       _cons |   1706.725   296.3112     5.76   0.000      1115.75    2297.699
------------------------------------------------------------------------------
```

Source: Own calculation in Stata

We can see that p-value is less than 0.05 which means less than significant level. And the coefficient is negative, which shows that the amount of asset-backed securities has an inverse relationship with the ROA. The possible reason might be that the higher the return of assets, the higher profitability of banks is rising, the lower the need for banks to make profits by issuing large-scale asset-backed securities.

Table 4.8 Regression model of Size and NPL

```
. regress Size NPLratio

      Source |       SS           df       MS      Number of obs   =        72
-------------+----------------------------------   F(1, 70)        =     17.86
       Model |  1437743.66         1  1437743.66   Prob > F        =    0.0001
    Residual |  5636615.33        70  80523.0762   R-squared       =    0.2032
-------------+----------------------------------   Adj R-squared   =    0.1919
       Total |  7074358.99        71  99638.8591   Root MSE        =    283.77

------------------------------------------------------------------------------
        Size |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    NPLratio |   528.6152   125.1005     4.23   0.000     279.1101    778.1203
       _cons |  -430.3148    204.495    -2.10   0.039    -838.1671   -22.46239
------------------------------------------------------------------------------
```

Source: Own calculation in Stata

We can see that p-value is less than 0.05 which means less than significant level. And the coefficient is positive, which shows that the amount of asset-backed securities has a positive change relationship with the NPL ratio. Because with the increase of NPL ratio, the credit risk faced by banks is increasing. At this time, issuing a large number of asset-backed securities is helpful for transfer risk.

Table 4.9 Regression model of Size and LR

```
. regress Size Liquidityratio

      Source |       SS           df       MS      Number of obs   =        72
-------------+----------------------------------   F(1, 70)        =     43.70
       Model |  2718825.68         1  2718825.68   Prob > F        =    0.0000
    Residual |  4355533.31        70  62221.9044   R-squared       =    0.3843
-------------+----------------------------------   Adj R-squared   =    0.3755
       Total |  7074358.99        71  99638.8591   Root MSE        =    249.44

--------------------------------------------------------------------------------
          Size |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
Liquidityratio |   56.79953   8.592622     6.61   0.000     39.66209    73.93698
         _cons |  -2404.943   428.6914    -5.61   0.000    -3259.942   -1549.945
--------------------------------------------------------------------------------
```

Source: Own calculation in Stata

We can see that p-value is less than 0.05 which means less than significant level. And the coefficient is positive, which shows that the amount of asset-backed securities has a positive change relationship with LR. As can be seen from formula (4.2), the higher the liquidity ratio, the stronger the bank's ability to cope with short-term debt. Therefore, high-liquidity banks are more capable of issuing asset-backed securities. On the contrary, the low liquidity ratio indicates that banks are not strong enough to participate in securitization.

Table 4.10 Regression model of Size and CAR

```
. regress Size CAR

      Source |       SS           df       MS      Number of obs   =        72
-------------+----------------------------------   F(1, 70)        =     53.19
       Model |  2977572.86         1  2977572.86   Prob > F        =    0.0000
    Residual |  3918608.21        70  55980.1173   R-squared       =    0.4318
-------------+----------------------------------   Adj R-squared   =    0.4237
       Total |  6896181.07        71  97129.3108   Root MSE        =     236.6

------------------------------------------------------------------------------
        Size |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         CAR |   229.6347   31.48641     7.29   0.000      166.837    292.4323
       _cons |  -2897.068   456.7183    -6.34   0.000    -3807.964   -1986.172
------------------------------------------------------------------------------
```

Source: Own calculation in Stata

We can see that p-value is less than 0.05 which means less than significant level. And the coefficient is positive, which shows that the amount of asset-backed securities has a positive change relationship with CAR. As mentioned in Chapter 2, the purpose of banks issuing asset-backed securities is not only to increase liquidity and avoid risks, but also to increase profits. The increase of CAR indicates that the bank's ability to face risks becomes stronger. This will increase investors' confidence in purchasing asset-backed securities. This means that the bank can safely issue more asset-backed securities to obtain profits.

4.3 Multivariable Regression Analysis

Based on the previous results in Chapter 4.2, we proved that five variables, IR, ROA, NPL, LR and CAR have a statistically significant relationship with the scale of asset securitization. Thus, in this part we will build a multivariate regression model to observe the effect of each independent variable on the dependent variable when all independent variables are used in one model.

4.3.1 Estimation of the Econometric Model

The goal of this part is to find the most suitable model through the transformation and combination of data forms in the case of existing data. This will set a basic framework for our regression model.

Table 4.11 Multivariable regression analysis by basic data

```
. regress Size IR ROA NPL LR CAR

      Source |       SS           df       MS      Number of obs   =        72
-------------+----------------------------------   F(5, 66)        =      9.65
       Model |  1576149.48         5  315229.896   Prob > F        =    0.0000
    Residual |  2157073.72        66  32682.9352   R-squared       =    0.4222
-------------+----------------------------------   Adj R-squared   =    0.3784
       Total |   3733223.2        71  52580.6085   Root MSE        =    180.78

------------------------------------------------------------------------------
        Size |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          IR |   95.36182   46.79691     2.04   0.046      1.92877    188.7949
         ROA |   497.8785   379.8661     1.31   0.195    -260.5487    1256.306
         NPL |   192.8902   192.6808     1.00   0.320    -191.8094    577.5897
          LR |  -1.490691   18.42751    -0.08   0.936     -38.2824    35.30102
         CAR |   147.1638   73.95317     1.99   0.051    -.4884453    294.8161
       _cons |  -2726.873    936.736    -2.91   0.005    -4597.127   -856.6195
------------------------------------------------------------------------------

. pwcorr Size IR ROA NPL LR CAR

             |     Size       IR      ROA      NPL       LR      CAR
-------------+------------------------------------------------------
        Size |   1.0000
          IR |   0.4458   1.0000
         ROA |  -0.3930  -0.3006   1.0000
         NPL |   0.4364   0.2296  -0.8816   1.0000
          LR |   0.5663   0.5617  -0.7117   0.6261   1.0000
         CAR |   0.6058   0.4524  -0.7550   0.7495   0.9156   1.0000
```

Source: Own calculation in Stata

From table 4.11 we can see that this model is not well. Coef. represents the coefficient of each variable, which is beta. We can see that the p-value of $\beta_2, \beta_3, \beta_4$are all higher than 0.05, which exceeds the significant level, which means the estimation of beta coefficients are not statistically significant. The adjusted R-squared is 0.3784. It means only 37% of the change in Size can be explained by independent variables. As can be seen from the correlation matrix, although the relationship between CAR and Size is relatively high, the overall correlation is not particularly high. So, the model is not particularly suitable.

Because the model using basic data does not reflect the relationship between various factors, we convert the basic data into various functional situations. This transformation is still studying the relationship between independent and dependent variables. What has changed is the presentation of the data. In this way, the relationship between the independent variable and the dependent variable is easier to find

So, in the next step, the data will be converted into ln function and a function composed of the difference between the original data and the lag (1) data. The optimal model will be found through this method.

Table 4.12 Multivariable regression analysis by lag data

```
. regress dSize dIR dROA dNPL dLR dCAR
```

Source	SS	df	MS
Model	351161.175	5	70232.2351
Residual	3273748.81	65	50365.3663
Total	3624909.98	70	51784.4284

Number of obs	=	71
F(5, 65)	=	1.39
Prob > F	=	0.2381
R-squared	=	0.0969
Adj R-squared	=	0.0274
Root MSE	=	224.42

dSize	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
dIR	161.8846	67.05372	2.41	0.019	27.96907	295.8001
dROA	1081.537	903.2729	1.20	0.236	-722.4241	2885.497
dNPL	-653.7116	1093.061	-0.60	0.552	-2836.705	1529.282
dLR	-31.8028	50.79744	-0.63	0.533	-133.2523	69.64669
dCAR	-83.07428	220.6084	-0.38	0.708	-523.6597	357.5112
_cons	30.0772	33.5953	0.90	0.374	-37.01726	97.17165

```
. pwcorr dSize dIR dROA dNPL dLR dCAR
```

	dSize	dIR	dROA	dNPL	dLR	dCAR
dSize	1.0000					
dIR	0.2625	1.0000				
dROA	0.0829	-0.1757	1.0000			
dNPL	-0.0262	0.0738	0.0945	1.0000		
dLR	-0.0394	0.0283	0.0984	-0.1493	1.0000	
dCAR	-0.0731	-0.0781	-0.0605	0.0144	-0.0564	1.0000

Source: Own calculation in Stata

From table 4.12 we can see that this model is also not well. The p-value of $\beta_2, \beta_3, \beta_{4,}\beta_5$are all higher than 0.05, which exceeds the significant level, which means the estimation of beta coefficients are not statistically significant. The adjusted R-squared is 0.0274. It means only 2% of the change in dSize can be explained by independent variables. As can be seen from the correlation matrix, the overall correlation is not particularly high. So, the model is also not good.

Table 4.13 Multivariable regression analysis by ln data

```
. regress lnSize lnIR lnROA lnNPL lnLR lnCAR
```

Source	SS	df	MS
Model	9.69036461	5	1.93807292
Residual	14.8285194	66	.224674537
Total	24.518884	71	.345336395

Number of obs	=	72
F(5, 66)	=	8.63
Prob > F	=	0.0000
R-squared	=	0.3952
Adj R-squared	=	0.3494
Root MSE	=	.474

lnSize	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnIR	.5016925	.2202872	2.28	0.026	.0618749	.94151
lnROA	1.353456	1.150501	1.18	0.244	-.9435932	3.650505
lnNPL	.7122927	.6756874	1.05	0.296	-.6367607	2.061346
lnLR	-1.599318	2.458552	-0.65	0.518	-6.507975	3.309338
lnCAR	6.41201	2.800662	2.29	0.025	.8203074	12.00371
_cons	-5.868688	5.475246	-1.07	0.288	-16.80037	5.062993

```
. pwcorr lnSize lnIR lnROA lnNPL lnLR lnCAR
```

	lnSize	lnIR	lnROA	lnNPL	lnLR	lnCAR
lnSize	1.0000					
lnIR	0.3843	1.0000				
lnROA	-0.3858	-0.2723	1.0000			
lnNPL	0.4452	0.1647	-0.8496	1.0000		
lnLR	0.5042	0.5000	-0.7318	0.6056	1.0000	
lnCAR	0.5754	0.3715	-0.7628	0.7501	0.9067	1.0000

Source: Own calculation in Stata

From table 4.13 we can see that this model is also not well. The p-value of $\beta_2, \beta_3, \beta_4$ are all higher than 0.05, which exceeds the significant level, which means the estimation of beta coefficients are not statistically significant. The adjusted R-squared is 0.3494. It means 34.94% of the change in lnSize can be explained by independent variables. As can be seen from the correlation matrix, although the relationship between lnCAR and lnSize is relatively high, the overall correlation is not particularly high So, the model is also not good.

It can be seen from Table 4.10-Table 4.12 that these three forms of models are not suitable for modelling our data. However, since the data is not stationary, the data has obvious autocorrelation. Although the linearity and unbiasedness of the estimator will not be affected, it loses its accuracy. This means that focusing on R-squared no longer makes sense. In this case, we will select the model with the most meaningful independent variables. Because the more meaningful independent variables, our analysis will be more comprehensive, and it is easier to identify the factors that may have an impact on the scale of asset securitization. As can be seen from the results of the three regression models, both the basic model and the lag model have only one meaningful independent variable, and the ln model has two meaningful independent variables, so we choose the ln model.

4.3.2 Statistical Verification of the Parameters and Model

In this part, we will test if the model we choose is statistically significant. Based on formula (3.10), formula (3.11), formula (3.16) and formula (3.17), t-test is used to detect β and F-test is used to detect the entire model.

Table 4.14 Verify β_1 by t-test

H0	$\beta_1 = 0$	H1	$\beta_1 \neq 0$
n	72	t_{cal}	2.28
k	6	t_{cri}	1.996
$\boldsymbol{\alpha}$	5%	Reject H0	

It can be seen from Table 4.14 that t_{cal} is greater than t_{cri} This shows that $\beta_1 \neq 0$ In other words, IR is meaningful.

Table 4.15 Verify β_2 by t-test

H0	$\beta_2 = 0$	H1	$\beta_2 \neq 0$
n	72	t_{cal}	1.18
k	6	t_{cri}	1.996
$\boldsymbol{\alpha}$	5%	Reject H1	

It can be seen from Table 4.15 that t_{cal} is smaller than t_{cri} This shows that $\beta_2 = 0$ In other words, ROA is meaningless.

Table 4.16 Verify β_3 by t-test

H0	$\beta_3 = 0$	H1	$\beta_3 \neq 0$
n	72	t_{cal}	1.05
k	6	t_{cri}	1.996
$\boldsymbol{\alpha}$	5%	Reject H1	

It can be seen from Table 4.16 that t_{cal} is smaller than t_{cri} This shows that $\beta_3 = 0$ In other words, NPL is meaningless.

Table 4.17 Verify β_4 by t-test

H0	$\beta_4 = 0$	H1	$\beta_4 \neq 0$
n	72	t_{cal}	-0.65
k	6	t_{cri}	1.996
$\boldsymbol{\alpha}$	5%	Reject H1	

It can be seen from Table 4.17 that the absolute value of t_{cal} is smaller than t_{cri} This shows that $\beta_4 = 0$ In other words, LR is meaningless.

Table 4.18 Verify β_5 by t-test

H0	$\beta_5 = 0$	H1	$\beta_5 \neq 0$
n	72	t_{cal}	2.29
k	5	t_{cri}	1.996
$\boldsymbol{\alpha}$	5%	Reject H0	

It can be seen from Table 4.18 that t_{cal} is bigger than t_{cri} This shows that $\beta_5 \neq 0$ In other words, CAR is meaningful.

By t-test, the coefficients of each variable, we found that the test results are consistent with the results shown in Table 4.13. This allows us to determine which variables are meaningful and which are meaningless in the model.

Table 4.19 Verify the whole model by F -test

H0	$\beta_1 = 0 \wedge \beta_2 = 0 \wedge \beta_3 = 0 \wedge \beta_4 = 0 \wedge \beta_5 = 0$	H1	$\beta_1 \neq 0 \cup \beta_2 \neq 0 \cup \beta_3 \neq 0 \cup \beta_4 \neq 0 \cup \beta_5 \neq 0$
n	72	F_{cal}	8.63
k	6	F_{cri}	2.35
$\boldsymbol{\alpha}$	5%	Reject H0	

It can be seen from Table 4.19 that F_{cal} is bigger than F_{cri} This shows that $\beta_1 \neq 0 \cup \beta_2 \neq 0 \cup \beta_3 \neq 0 \cup \beta_4 \neq 0 \cup \beta_5 \neq 0$. In other words, this model is meaningful.

From Table 4.13 to 4.18 we can see that our model is meaningful. But only variables lnIR and lnCAR are statistically significant. In this way, we can get the new model:

$$\text{lnSize} = \beta_0 + \beta_1 \text{lnIR} + \beta_2 \text{lnCAR} + u \quad (4.7).$$

Table 4.20 Regression of new model

. regress lnSize lnIR lnCAR

Source	SS	df	MS
Model	8.94580317	2	4.47290159
Residual	15.5730809	69	.225696824
Total	24.518884	71	.345336395

Number of obs	=	72
F(2, 69)	=	19.82
Prob > F	=	0.0000
R-squared	=	0.3649
Adj R-squared	=	0.3464
Root MSE	=	.47508

lnSize	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnIR	.382453	.1998277	1.91	0.060	-.0161923	.7810983
lnCAR	4.820424	.9923556	4.86	0.000	2.840728	6.800119
_cons	-7.219887	2.606856	-2.77	0.007	-12.42042	-2.019352

Source: Own calculation in Stata

We can see from Table 4.20, the p-value of β_1 is higher than 0.05. It means we need change a form of factors in our model. It can convert lnSize data to Size data.

$$\text{Size}= \beta_0+\beta_1\text{lnIR}+\beta_2\text{lnCAR}+u \qquad (4.8).$$

Table 4.21 Regression of changed new model

. regress Size lnIR lnCAR

Source	SS	df	MS
Model	1516754.75	2	758377.373
Residual	2216468.46	69	32122.7313
Total	3733223.2	71	52580.6085

Number of obs	=	72
F(2, 69)	=	23.61
Prob > F	=	0.0000
R-squared	=	0.4063
Adj R-squared	=	0.3891
Root MSE	=	179.23

Size	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnIR	170.0296	75.38747	2.26	0.027	19.63573	320.4235
lnCAR	1942.443	374.3784	5.19	0.000	1195.578	2689.307
_cons	-4869.43	983.4686	-4.95	0.000	-6831.397	-2907.464

Source: Own calculation in Stata

We can see from Table 4.21, the p-values of all coefficients are less than 0.05, and R squared is at a accetable level.

4.3.3 Autocorrelation

Autocorrelation is the correlation of a signal with a delayed copy of itself as a function of delay. Informally, it is the similarity between observations as a function of the time lag between them.

Based on the formula 3.18, we can use the Durbin Waston analysis to get the result.

Table 4.22 Result of Durbin Waston test

```
. dwstat

Durbin-Watson d-statistic(   3,     72) =  1.534942

.
```

Source: Own calculation in Stata

From table 4.22 we can see that the result of DW test is quite a distance from 2. By checking Durbin Watson table, when k=3, n=72 the upper limit is 1.557 and the lower limit is 1.395. The test result is 1.534, smaller than upper limited. So, we can say that the model has an autocorrelation.

After proving the existence of autocorrelation, we need to find a way to eliminate autocorrelation. Based on the way introduced in chapter 3.2.5, Cochrane-Orcutt method can be used to eliminate the autocorrelation.

Table 4.23 Cochrane-Orcutt method

Cochrane-Orcutt AR(1) regression -- iterated estimates

Source	SS	df	MS
Model	912907.244	2	456453.622
Residual	2085924.48	68	30675.36
Total	2998831.73	70	42840.4532

Number of obs	= 71
F(2, 68)	= 14.88
Prob > F	= 0.0000
R-squared	= 0.3044
Adj R-squared	= 0.2840
Root MSE	= 175.14

Size	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnIR	212.5811	86.66365	2.45	0.017	39.64651	385.5157
lnCAR	1772.552	501.0622	3.54	0.001	772.6976	2772.406
_cons	-4439.395	1319.86	-3.36	0.001	-7073.134	-1805.656
rho	.2385828					

Durbin-Watson statistic (original) 1.534942
Durbin-Watson statistic (transformed) 1.911716

Source: Own calculation in Stata

From Table 4.23, we can see that the test value of the modified model is 1.911, which is higher than the upper limit of 1.557. This shows that the autocorrelation is eliminated. And the p-values of all coefficients are less than 0.05, which shows that the coefficients are statistically significant.

4.3.4 Heteroskedasticity

The goal of this part is to detect whether the final model has heteroscedasticity. As mentioned in Chapter 3, White 's test will be used to determine whether the model has heteroscedasticity. Based on formula 3.21, the new model is:

$u_t^2 = \alpha_1 + \alpha_2 x_{1t} + \alpha_3 x_{2t} + \alpha_4 {x_{1t}}^2 + \alpha_5 {x_{2t}}^2 + \alpha_6 x_{1t} x_{2t} + \epsilon_t$

Table 4.24 White's test

```
. estat imtest, white

White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(14)      =      9.14
         Prob > chi2   =    0.8217

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	9.14	14	0.8217
Skewness	5.18	5	0.3944
Kurtosis	-4625.20	1	1.0000
Total	-4610.88	20	1.0000

Source: Own calculation in Stata

We can see that p-value = 0.8217> 0.05, so we do not reject H0, there is homoscedasticity at 5% level of sign. This means that the model has homoscedasticity. The random error terms in the population regression function satisfy the same variance, that is, they all have the same variance.

4.3.5 Multicollinearity

The purpose of this section is to test whether the model has multicollinearity. We mentioned in Chapter 3 that we will use VIF to test the model. But before that, we can use pair correlation to make a simple guess as to whether the model has multicollinearity.

Table 4.25 Pair correlation between lnIR and lnCAR

```
. pwcorr lnIR lnCAR
```

	lnIR	lnCAR
lnIR	1.0000	
lnCAR	0.3715	1.0000

.

Source: Own calculation in Stata

As can be seen from Table 4.25, the correlation between lnIR and lnCAR is 0.3715. This is a small value. From this we can assume the model does not have multicollinearity. Next, we use the Variance Inflation Factor to test whether multicollinearity exists in our model.

Table 4.26 Result pf VIF

```
. vif
```

Variable	VIF	1/VIF
lnCAR	1.16	0.861995
lnIR	1.16	0.861995
Mean VIF	1.16	

Source: Own calculation in Stata

From Table 4.26 we can see that the VIF of our model is 1.16. This value is very small. When the VIF is between 1 and 10, we don't consider this model to have multicollinearity. Our VIF is 1.16, between 1 and 10. This shows that our model does not have multicollinearity.

4.3.6 Model Specification

In the previous test, we found that our model R square is not very high. This is probably because we have missed some variables. In this part, we will test if all important variables are in the model and if linear dependence is the good one for the model.
Based on the way introduced in chapter 3.3.6, Ramsey RESET test can be used to identify whether the model is correctly specified.
H0 : regression model is correctly specified
H1 : regression model is not correctly specified

Table 4.27 Ramsey RESET Test

```
. ovtest

Ramsey RESET test using powers of the fitted values of Size
       Ho:  model has no omitted variables
                  F(3, 64) =      0.12
                  Prob > F =      0.9490

.
```

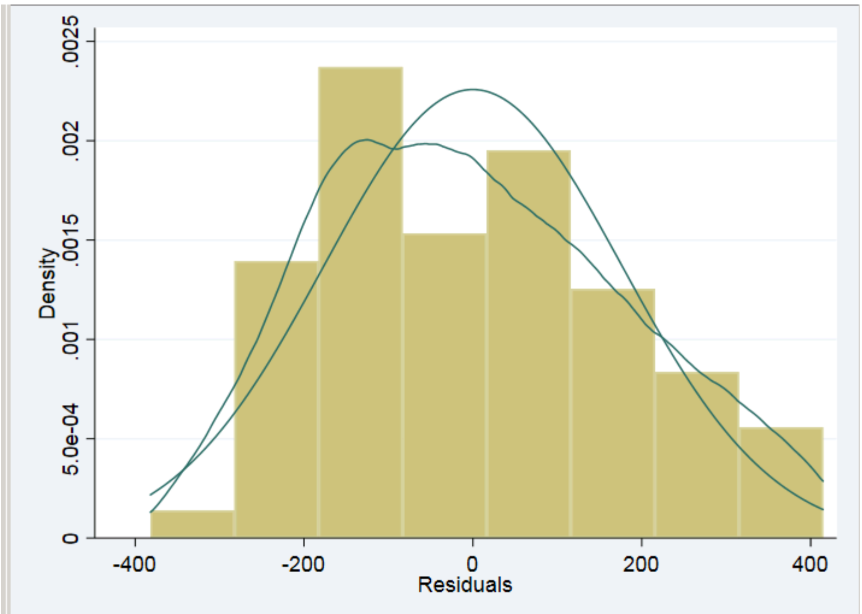
Source: Own calculation in Stata

We can see that P-value is bigger than significant level. So, we reject H1. In other words, we can assume that the model is correct specified at significant level 0.05. This means that although the R-squared of our model is not very high, our main variables have been found. The rest is composed of various non-primary variables. This means that SIZE is affected by many small factors.

4.3.7 Normality of Residuals

The purpose of this section is to detect whether the residuals conform to a normal distribution. Through the introduction in Chapter 3, we know that the normal distribution of residuals should be symmetric and has a bell-shape with a peak and tail-thickens leading to a kurtosis of 3. Thus, we can test for departures form normality by checking the skewness and kurtosis from a sample data. If skewness is not close to zero, and if kurtosis is not close to 3 we would reject the normality of the population.
First, we can analyze through the graph.

Figure 4.2 Normality of residuals



Source: Own calculation in Stata

We can see from Figure 4.2 that whether it is kurtosis or skewness, our residuals are not much different from normal density. So, we preliminarily judge that our residuals are in line with the normal distribution. And in order to get more accurate judgment, Jarque-Bera test can be used.

H0 : residuals are normal distributed

H1 : residual are not normal distributed

Table 4.28 Jarque-Bera test

```
. sktest residua
```

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2) (joint)	Prob>chi2 (joint)
residua	72	0.2437	0.1874	3.22	0.1998

Source: Own calculation in Stata

We can see from table 4.27 that P-value = 0.1998, Skewness is 0.2437, kurtosis is 0.1874. P-value is greater than 0.05, so we reject H1. This means that the residuals fit a normal distribution.

4.3.8 Summary of Results

Chapter 4 focuses on the factors that affect Size. Because Size is the amount of asset-backed securities issued by commercial banks, it can best reflect the scale of commercial bank asset securitization. Through a series of calculations and tests, the regression model we finally found is:

$$Size=-4439.395+212.5811\ \ln IR+1772.552\ \ln CAR \tag{4.9}$$

Based on univariable analyses, Size has little relationship with RF, Size has positive relation with IR, NPL, LR and CAR, and Size has negative relation with ROA. Although because of the mutual influence between the independent variables, not all these variables have statistical significance in the multivariable model, we can see through the univariate model that there is a certain relationship between these variables and the scale of securitization.

The reason of why Size has negative relation with ROA may be that the higher the return of assets, the higher profitability of banks is rising, the lower the need for banks to make profits by issuing large-scale asset-backed securities. The reason of why Size has positive relation with IR may be that as the inflation rate rises, purchasing power of cash is depreciating. Low-liquidity assets in the hands of banks will become less and less valuable. At this time, banks will issue many asset-backed securities to transfer this risk. Size has positive relation with NPL may because with the increase of NPL ratio, the credit risk faced by banks is increasing. At this time, issuing a large number of asset-backed securities is helpful for transfer risk. Size has positive relation with LR may because of high-liquidity banks are more capable of issuing asset-backed securities. On the contrary, the low liquidity ratio indicates that banks are not strong enough to participate in securitization. The reason of why Size has positive relation with CAR may be that the purpose of banks issuing asset-backed securities is not only to increase liquidity and avoid risks, but also to increase profits. The increase of CAR indicates that the bank's ability to face risks becomes stronger. This will increase investors' confidence in purchasing asset-backed securities. This means that the bank can safely issue more asset-backed securities to obtain profits.

Based on multivariable analyses, Size (hundred million yuan) has a positive relation with lnIR. When lnIR increase 1 unit, Size will increase by 212.5811(hundred million yuan). Size (hundred million yuan) has a positive relation with lnCAR. When lnCAR increase 1 unit, Size will increase by 1772.552(hundred million yuan)

Through T-test and F-test, we determined that the model is statistically significant. But the five variables we selected, only two were statistically significant. When testing the residuals, we found that there is a first-order autocorrelation. We try to eliminate autocorrelation, but after eliminating autocorrelation, the model still has a low R squared. Next, we found that the model does not have heteroscedasticity and multicollinearity. And the residuals fit a normal distribution.

From the results, the scale of asset securitization of Chinese commercial banks is mainly affected by the inflation rate and capital adequacy ratio. In other words, on the one hand, the scale of asset securitization of Chinese commercial banks is affected by the macroeconomic environment. On the other hand, it is affected by banks' ability to respond to risks. However, the R squared of our model is always not high. This shows that only a small amount of change in Size can be explained by the independent variable. In other words, in addition to the independent variables we mentioned, the scale of asset securitization of Chinese commercial banks is likely to be affected by many other factors.

5 Conclusion

Securitization is playing an increasingly important role in China's financial market. From the issuer's perspective, securitization can enhance the liquidity of assets, reduce risk of assets and make profits. From the perspective of investors, asset-backed securities provide higher returns than government bonds. Therefore, studying the factors affecting the scale of securitization will be of great significance to the bank's financing model and investors' investment direction.

Through the estimation of the multivariate regression model, it can be seen that the scale of commercial bank securitization is related to the inflation rate and the bank's capital adequacy ratio. Among them, the inflation rate represents the macroeconomic environment, as the inflation rate rises, cash is depreciating. Low-liquidity assets in the hands of banks will become less and less valuable. At this time, banks will issue more asset-backed securities to transfer this risk. The capital adequacy ratio represents the bank's ability to face risks. The increase of CAR indicates that the bank's ability to face risks becomes stronger. This will increase investors' confidence in purchasing asset-backed securities. This means that the bank can safely issue more asset-backed securities to obtain profits. The model (formula 4.9) can simply predict the trend of asset securitization to a certain extent. This has a guiding role in how banks transfer risks and how investors choose asset-backed securities investments. From a practical perspective, from 2014 to 2019, the minimum IR value is 0.8 and the maximum value is 3.4. After being converted into ln form, the smallest lnIR is -0.22 and the largest lnIR is 1.22. We can clearly see that the variation of the original data is greater than the variation of ln function. The minimum value of CAR is 12.56 and the maximum value is 16.2. The minimum value of lnCAR is 2.53, and the maximum value is 2.79. It can also be seen that the variation of the original CAR data is greater than the variation of lnCAR. This shows that after the original data is converted to ln form, the fluctuation of the data becomes smaller. This means that small changes in the original data are more difficult to be presented in our model, and we must improve the accuracy to see the effect of changes in the original data on Size. (For example, change the data from displaying 4 digits to displaying 6 digits). On the other hand, only when the original data has a large change will it cause the ln function to change. We know that, no matter it is IR or CAR, when it is measured with monthly data, its variation range is actually very small. In many cases, changes in IR or CAR for several months have caused only small changes in Size, making it difficult to observe the overall trend. When using the ln function, small changes in the original data are difficult to show. This means that every small change in the ln function means a large change in the original data. This makes it easier for us to observe the overall trend of changes. At the same time, by comparing the coefficients of lnIR and lnCAR, we can see that the coefficient of lnCAR is larger. This means that when lnIR and lnCAR change the same ratio, lnCAR has a greater impact on Size. This means that investors or commercial banks should pay more attention to the factors of capital adequacy when estimating the scale of securitization.

However, the R-square of the model is not high, but in chapter 4.3.6, we proved that our model is good, and the main variables are not omitted. This means that Size is affected by many small factors, which together form the remaining 0.7 R square.

As is known to all, China's political and economic system determines that China's securitization market is very different from other countries. In China, most large commercial banks are state-owned, and the Central Bank of China, which leads commercial banks, is led by the Communist Party of China. At the same time, the government is also led by the Communist Party of China. Although the central bank is legally independent, the people involved in decision-making are basically Communist Party members, so the Central Bank of China is largely affected by government policies. This is also reflected in commercial banks.

For factors not mentioned in the model, the policy factor is a typical unquantifiable factor. In many cases, banks participate in securitization because of government requirements. Because the Chinese securitization market started late, the Chinese government needs more tests to confirm how to promote securitization.

Compared to Europe and the United States, China's securitization market started late, and there are not many commercial banks that are strong enough to participate. At the same time, due to political and economic factors, the weights of various factors affecting the securitization of Chinese commercial banks are also different from those of Europe and the United States.

With the development of securitization, China's securitization market will become larger and larger in the future, and the factors that affect the securitization of Chinese commercial banks in the future may be very different from those of the present. Since securitization has a positive effect on transferring risks and increasing bank liquidity, there will be more and more commercial banks participating in the securitization market, and the autonomy of commercial banks will become stronger and stronger. It is also difficult for government policy factors to cover the entire securitization market. At the same time, the proportion of macro factors such as inflation rate will be lower and lower, and commercial banks will pay more attention to their own micro factors. The impact of the capital adequacy ratio will become smaller and smaller, because after there are more commercial banks participating in securitization, investors pay more attention not to risk but profit.

Overall, the factors affecting the scale of securitization of Chinese commercial banks are varied and constantly changing. Analyzing the factors affecting the scale of securitization of commercial banks in China is helpful to understand their development trends and their source of income.

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List of Abbreviations

Size	The amount of asset-backed securities and mortgage back securities
RF	Ten-year Government Bond Rate
IR	Inflation Rate
ROA	Return on Assets
LR	Liquidity Ratio
NPL	Non-performing Loan Ratio
CAR	Capital Adequacy Ratio
ABS	Asset Back Security
MBS	Mortgage Back Security
SPV	Special Purpose Vehicle
CMOs	Collateralized Mortgage Obligations
SMBS	Stripped Mortgage Back Security
IO	Interest Only
PO	Principal Only
ICBC	Industrial and Commercial Bank of China
IPO	Initial Public Offering
SPD	Shanghai Pudong Development Bank
SDB	Shenzhen Development Bank
Var	Variance
Cov	Covariance
ρ	Correlation
ACF	Auto Correlation Function
PACF	Partial Autocorrelation Function
AC	Auto Correlation
DW test	DURBIN–WATSON test
VIF	Variance Inflation Factor
σ	Standard deviation
RESET	Regression Specification Error Test

OLS	Ordinary Least Square Model

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Ostrava dated 27.04.2020

金高阁 Jin Gaoge

Student's name and surname

List of Annexes

Annex 1: Data for analysis

time	Size（100 million yuan）	10 year treasury bond yield（%）	Inflation rate(%)
2014M1	12.38	4.55	2.5
2014M2	102.5	4.42	2
2014M3	367.72	4.48	2.4
2014M4	29.29	4.33	1.8
2014M5	284.77	4.16	2.5
2014M6	42.31	4.06	2.3
2014M7	135.42	4.298	2.3
2014M8	382.91	4.248	2
2014M9	366.71	4.028	1.6
2014M10	212.3	3.786	1.6
2014M11	211.06	3.546	1.4
2014M12	672.44	3.648	1.5
2015M1	151.7	3.514	0.8
2015M2	212.5	3.379	1.4
2015M3	143.67	3.623	1.4
2015M4	10.41	3.422	1.5
2015M5	38.14	3.591	1.2
2015M6	573.4	3.629	1.4
2015M7	259.69	3.474	1.6
2015M8	290.76	3.394	2
2015M9	673.83	3.276	1.6
2015M10	95.45	3.087	1.3
2015M11	585.88	3.088	1.5
2015M12	1020.9	2.862	1.6
2016M1	155.43	2.909	1.8
2016M2	77.08	2.909	2.3
2016M3	221.86	2.886	2.3
2016M4	195.66	2.946	2.3
2016M5	237.28	2.995	2
2016M6	458.52	2.875	1.9
2016M7	74.31	2.805	1.8
2016M8	170.45	2.805	1.3
2016M9	472.97	2.769	1.9
2016M10	289.43	2.744	2.1
2016M11	540	2.943	2.3

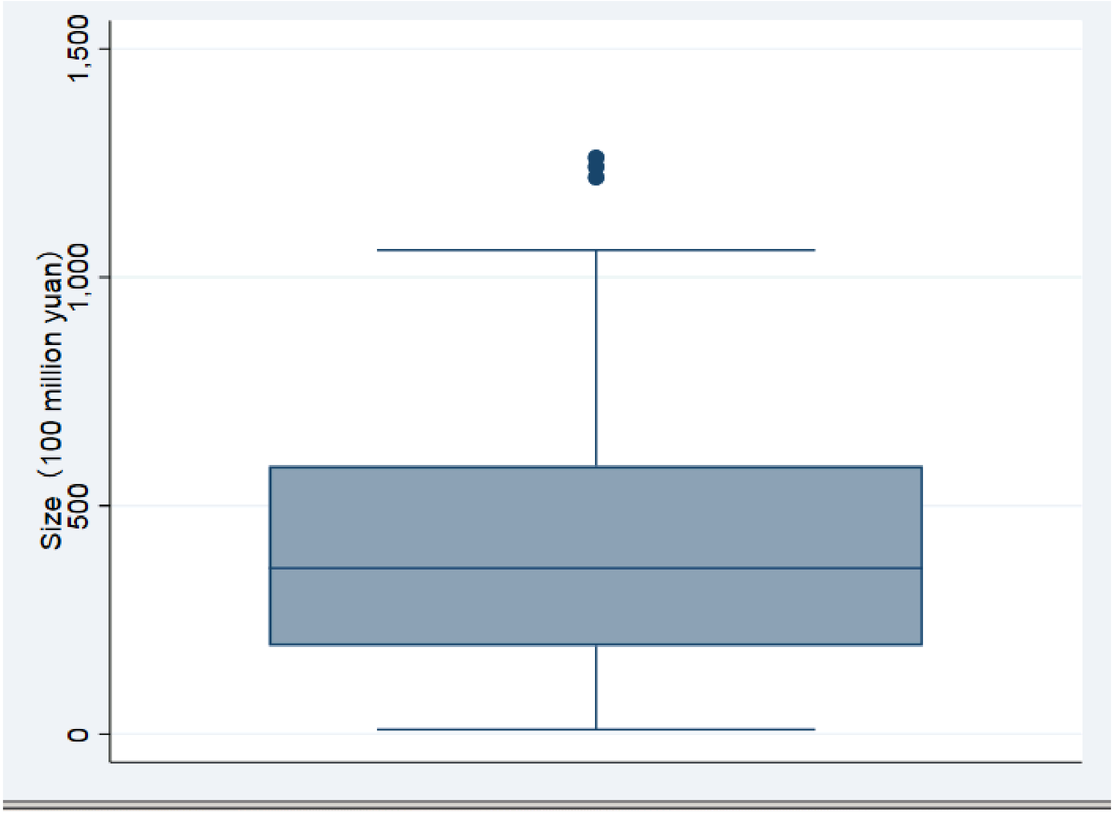
2016M12	399.89	3.066	2.1
2017M1	259.77	3.363	2.5
2017M2	191.68	3.358	0.8
2017M3	314.03	3.31	0.9
2017M4	241.03	3.477	1.2
2017M5	644.62	3.67	1.5
2017M6	260.69	3.578	1.5
2017M7	107.62	3.629	1.4
2017M8	707.51	3.675	1.8
2017M9	498.9	3.638	1.6
2017M10	457.51	3.916	1.9
2017M11	471.16	3.917	1.7
2017M12	327.67	3.915	1.8
2018M1	184.17	3.944	1.5
2018M2	396.14	3.857	2.9
2018M3	608.11	3.778	2.1
2018M4	517.07	3.653	1.8
2018M5	426.02	3.646	1.8
2018M6	587.89	3.543	1.9
2018M7	750.53	3.533	2.1
2018M8	872.86	3.6	2.3
2018M9	1218.5	3.655	2.5
2018M10	421.72	3.533	2.5
2018M11	360.81	3.398	2.2
2018M12	360.79	3.27	1.9
2019M1	299.89	3.13	1.7
2019M2	151.47	3.208	1.5
2019M3	787.06	3.075	2.3
2019M4	914.72	3.416	2.5
2019M5	554.91	3.297	2.7
2019M6	859.75	3.279	2.7
2019M7	1002.48	3.183	2.8
2019M8	539.96	3.068	2.8
2019M9	760.34	3.155	3
2019M10	1059.51	3.281	3.2
2019M11	1261.68	3.192	3.3
2019M12	1241.6	3.174	3.4

time	ROA（%）	NPL ratio（%）	Liquidity ratio（%）	Capital adequacy ratio（%）
2014M1	1.3	1.01	45.32	12.56
2014M2	1.38	1.03	45.78	12.58
2014M3	1.42	1.04	46.3	12.62
2014M4	1.47	1.04	46.29	12.89
2014M5	1.43	1.05	46.13	12.97
2014M6	1.45	1.07	47.22	13.22
2014M7	1.45	1.08	47.52	13.57
2014M8	1.44	1.12	47.31	13.68
2014M9	1.42	1.15	48.17	13.92
2014M10	1.42	1.16	48.53	14.1
2014M11	1.38	1.18	47.73	14.21
2014M12	1.34	1.22	46.21	14.19
2015M1	1.3	1.25	46.44	14.17
2015M2	1.32	1.29	48.42	14.02
2015M3	1.37	1.34	47.78	13.95
2015M4	1.37	1.39	47.46	13.81
2015M5	1.35	1.44	47.51	13.83
2015M6	1.33	1.47	46.92	13.91
2015M7	1.32	1.5	46.18	13.99
2015M8	1.34	1.52	46.64	14.15
2015M9	1.32	1.55	46.42	14.23
2015M10	1.31	1.59	46.16	14.5
2015M11	1.28	1.62	47.17	14.42
2015M12	1.25	1.66	47.65	14.38
2016M1	1.2	1.67	48.01	14.35
2016M2	1.26	1.73	47.84	14.21
2016M3	1.28	1.73	47.92	14.02
2016M4	1.29	1.75	48.08	13.89
2016M5	1.25	1.68	47.97	13.92
2016M6	1.22	1.72	48.07	14.01
2016M7	1.2	1.75	48.14	14.16
2016M8	1.19	1.73	47.75	14.11
2016M9	1.2	1.75	47.21	14.2
2016M10	1.17	1.76	46.93	14.23
2016M11	1.13	1.72	47.3	14.15
2016M12	1.09	1.73	47.42	14.18
2017M1	1.07	1.74	47.55	14.14
2017M2	1.13	1.75	47.69	14.12
2017M3	1.14	1.74	48.23	14.08

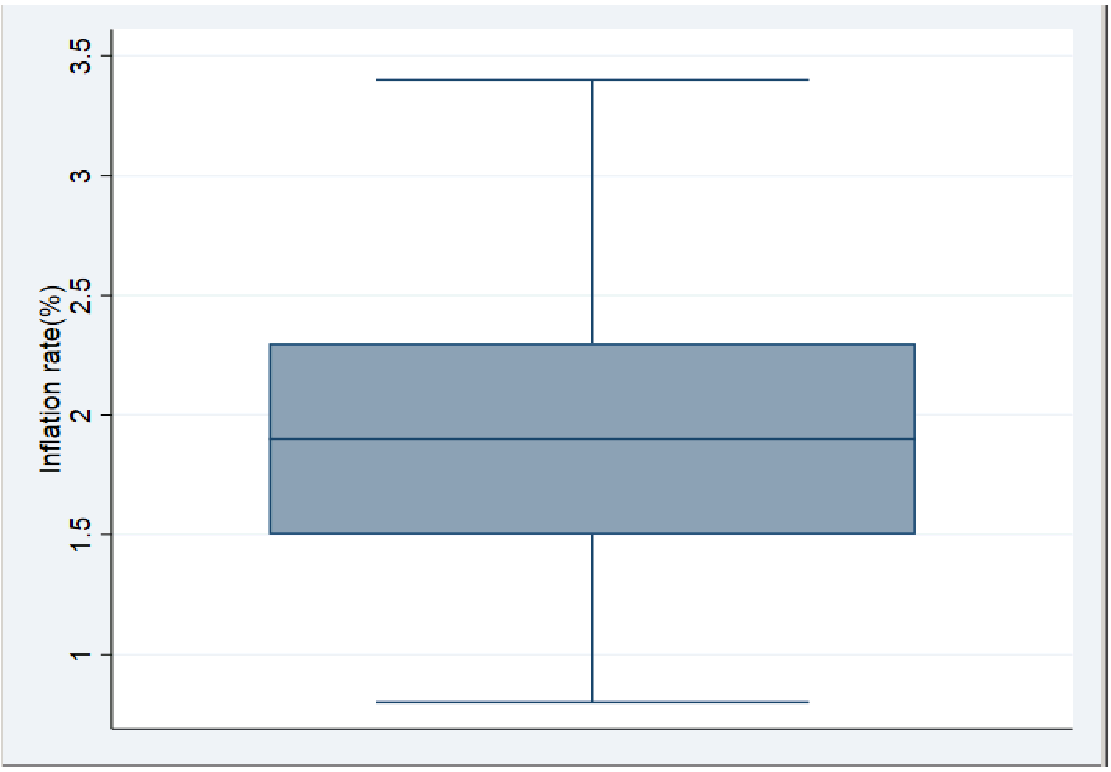
2017M4	1.15	1.74	48.74	13.94
2017M5	1.14	1.72	48.87	14.08
2017M6	1.15	1.76	49.09	14.14
2017M7	1.15	1.74	49.52	14.17
2017M8	1.14	1.77	49.32	14.25
2017M9	1.12	1.75	49.16	14.43
2017M10	1.12	1.74	49.17	14.65
2017M11	1.08	1.72	49.52	14.52
2017M12	1.03	1.71	49.73	14.57
2018M1	1.02	1.74	50.03	14.63
2018M2	1.01	1.76	50.12	14.6
2018M3	1.08	1.77	50.64	14.68
2018M4	1.13	1.75	51.39	14.73
2018M5	1.12	1.79	51.44	14.82
2018M6	1.13	1.83	51.87	14.91
2018M7	1.14	1.86	52.42	15.04
2018M8	1.14	1.82	52.51	15.14
2018M9	1.12	1.85	52.54	15.36
2018M10	1.1	1.87	52.94	15.7
2018M11	1.05	1.86	53.06	15.62
2018M12	1.03	1.84	53.87	15.65
2019M1	1	1.83	55.31	15.67
2019M2	1.04	1.83	55.46	15.58
2019M3	1.04	1.82	56.58	15.63
2019M4	1.07	1.8	56.81	15.66
2019M5	1.06	1.83	56.42	15.77
2019M6	1.08	1.81	55.91	15.82
2019M7	1.09	1.81	55.77	16.18
2019M8	1.12	1.84	55.59	16.12
2019M9	1.07	1.86	55.89	16.17
2019M10	1.05	1.86	57.02	16.2
2019M11	1.06	1.85	56.68	16.17
2019M12	1.05	1.86	56.91	16.19

Annex 2: Box plot of each factors

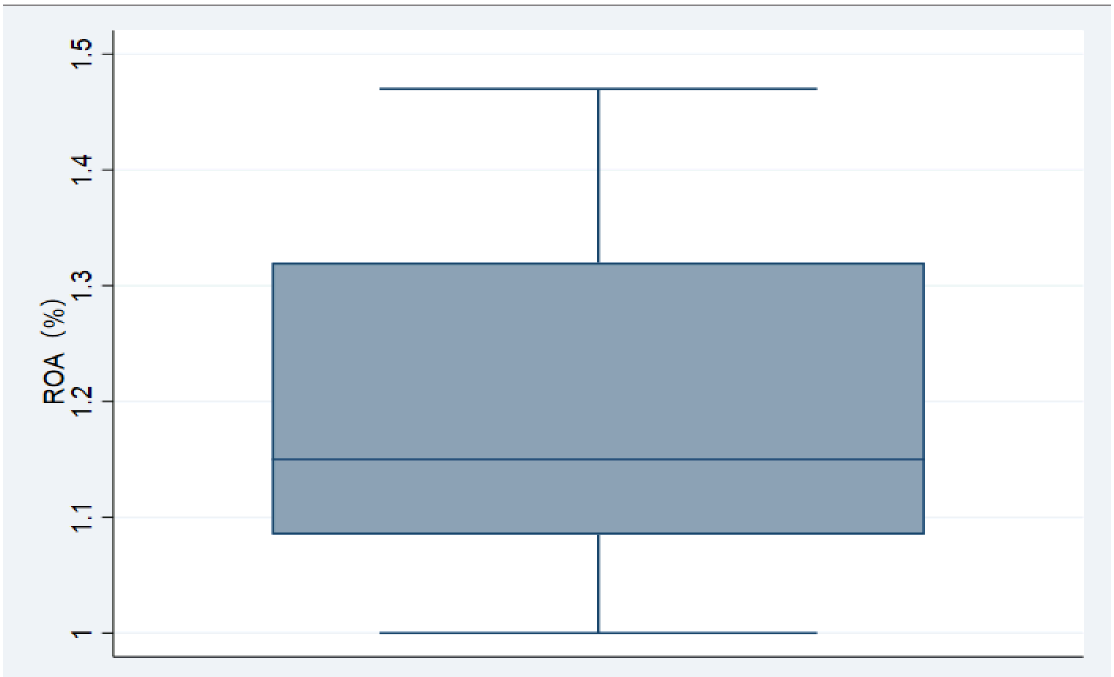
Box plot of Size



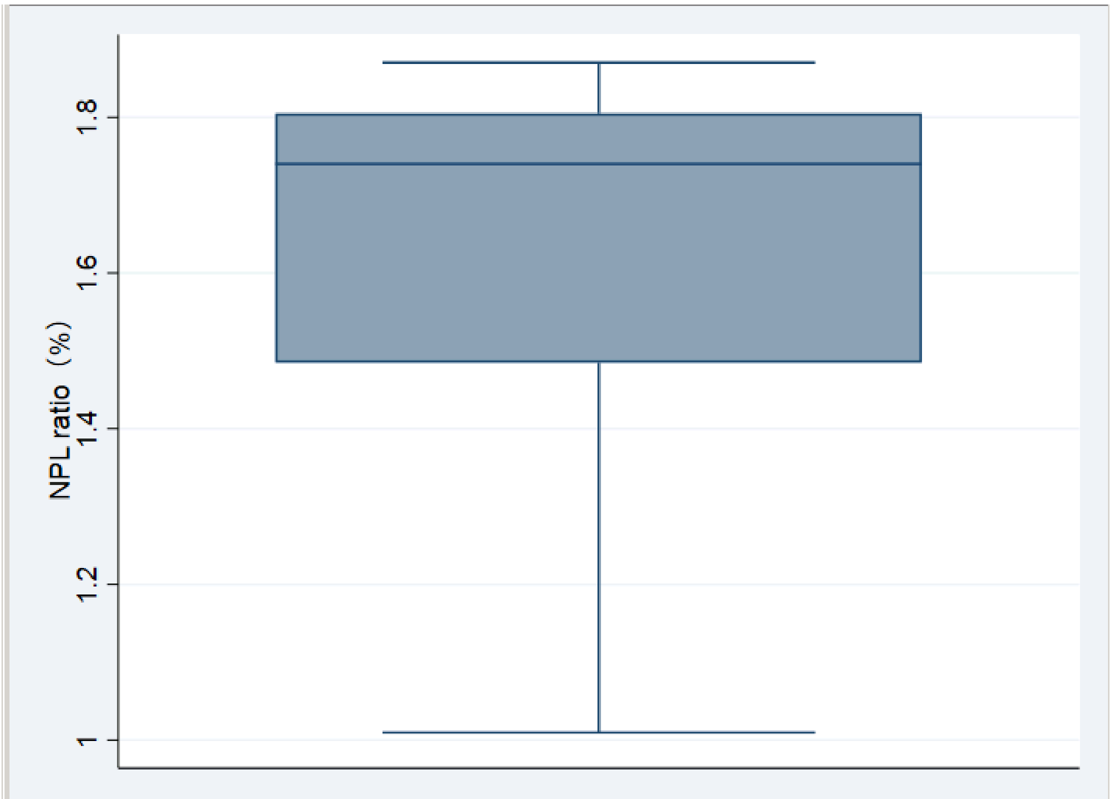
Box plot of IR



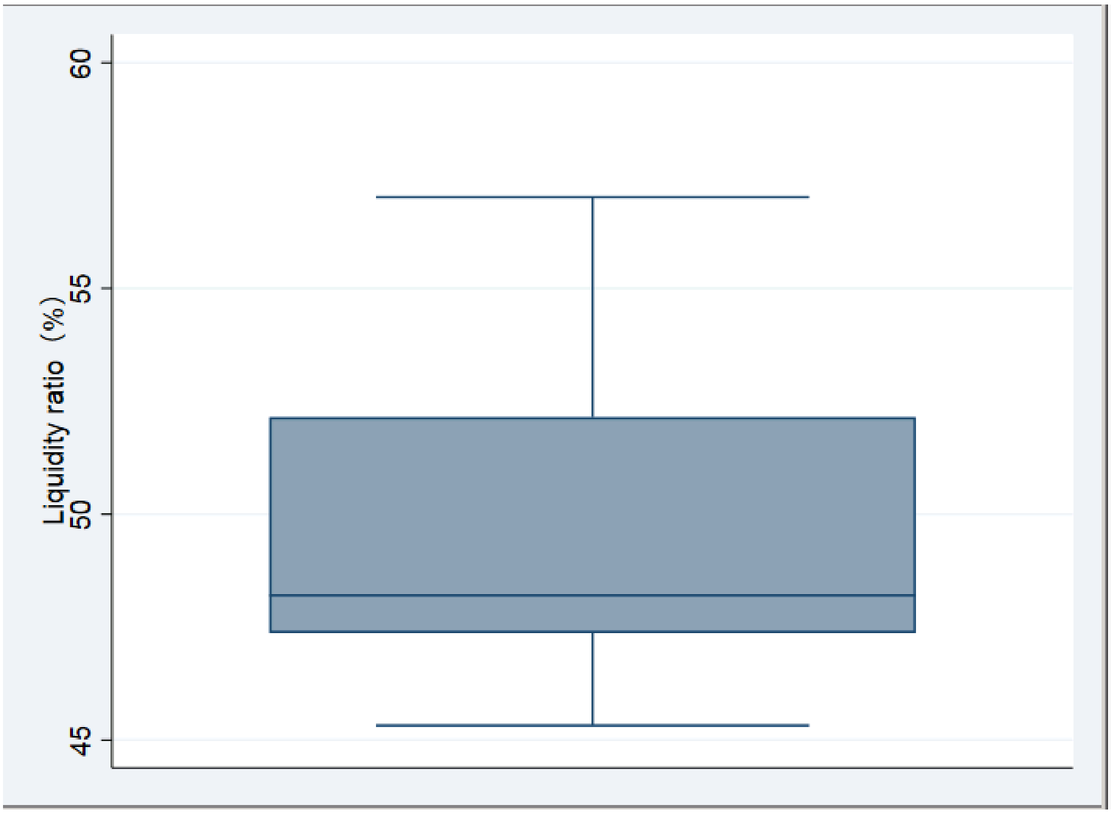
Box plot of ROA



Box plot of NPL



Box plot of LR



Box plot of CAR